POWER

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Caliper Yourself

Inspired by an address by George Kingdon Parsons before the student members of the American Society of Mechanical Engineers at New York on April 1, 1921.

YOUNG man, caliper yourself—that you may utilize to the full your brains, your skill and your training—that you may avoid the tragedy of a life of wasted effort.

Chief among the lessons you have learned in school is that the use of mechanical forces is an exact science. The use of human energy is not an exact science. It is, therefore, difficult to understand and to control. For that reason it is invariably neglected.

Is it not possible that you, like many other young fellows, are just gravitating into a profession without much thought as to what you are doing? Perhaps your confidence in yourself is such that you think you can make good at anything you try. Perhaps you are justified. Some people act on the same principle when they buy a motor that will "do anything," paying far more in the first cost and for current than if they had bought one adapted to its particular job.

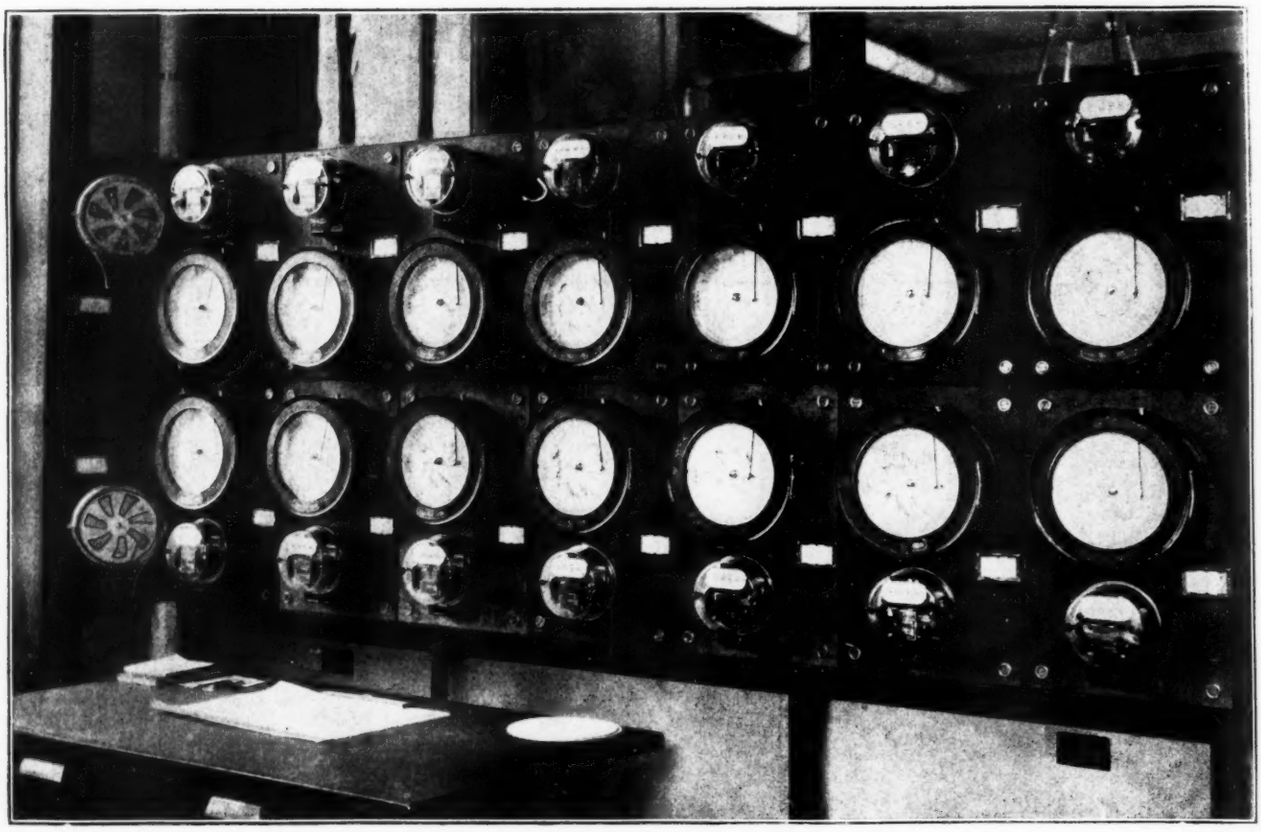
Did you ever take the time and trouble to make a careful analysis of the real reasons that guided you in choosing your lifework? Is it that your father is in the business, or that a friend could give you a good start? Such reasons have some weight, but they too often are the only reasons considered.

If you were to design a shaft and a bearing, how carefully you would determine the load to be carried, the power transmitted, the speed of the shaft. With these data in mind, how precisely you would specify the quality of the material, the diameter and length of the bearing, the methods of mounting, adjustment, lubrication. With what nicety you would caliper the finished shaft and the bearing, to make sure that they would run smoothly, have a long life and waste the least possible amount of power.

If you should blunder at such a task, some thousands of dollars might be wasted. Yet if you blunder in the choice of an occupation that you are fitted for, your whole life will be wasted.

To do your work from day to day is not enough. Try to use as much care and skill in choosing a suitable career as you have been taught to use in designing a big machine.

Measure yourself and the job you are seeking —see that they fit.



METER BOARD IN CHIEF ENGINEER'S OFFICE

Load Dispatching in a Central Heating System

By J. C. BUTLER
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CENTRAL-STATION heating in Chicago had its beginning many years ago, when steam service was supplied small buildings adjoining a larger building in the same block, the service being given by the larger as an aid in overcoming the smoke nuisance from the smaller boiler plants. It was on this basis that the Illinois Maintenance Co., as well as many private building owners, began to distribute steam in Chicago, the piping being run in the basements of buildings in the same block as that in which the steam-generating plant was situated, thereby eliminating the expense of placing piping in the city streets and alleys.

It has been only within the past few years that tie lines have been installed between steam-generating plants of the Illinois Maintenance Co., thereby protecting the service and making it possible to effect certain operating economies that could not have been obtained otherwise. Such a system is shown in Fig. 1, which comprises six steam-generating plants, buildings and customers in thirteen city blocks in the loop district of Chicago. This is only a part of the entire system operated by the company. The benefit of such a system of steam distribution is great, as it is possible to supply from six boiler plants a total of forty-nine steam customers, eighteen of whom formerly operated their own individual boiler plants and twenty-six of whom would have had to install boilers of their own had not the outside steam service been available. In this way it has been possible to concentrate the smoke to a maximum of six stacks, instead of a possible forty-four. The fuel is burned in the more efficient boiler plants located in the larger buildings with stacks extending above the surrounding buildings, which it would be impossible for each individual building to do.

In a system of this kind it is possible to reduce or to increase the number of boiler plants in service at any one time as the seasons change, all the load being carried from the plant in the Edison Building during the summer months and the other plants being cut in or out as the case may be, depending on the outside temperature conditions. The size of the steam-generating plants, principal customers, size and character of the load are given in the accompanying table for the system shown in Fig. 1. Before connections were made between the boiler plants of the

Measuring the flow of steam blocks away from the connection to the line is something new in the steam-heating industry. This is being done by the Illinois Maintenance Co., Chicago, and a most attractive meter board in the chief engineer's office concentrates all data necessary to visualize the operation of the system and for load dispatching between plants.

system, the engineer in each plant knew the character of his load and could govern his plant-operating conditions accordingly, but under the present system it is necessary to have a load dispatcher who notifies the engineer as to what procedure he shall follow.

With boiler plants and customers scattered over thirteen city blocks, it was a problem as to what would be the best method of obtaining the information necessary for the proper handling of the load conditions and boiler-plant operation. The offices of the company are on the eleventh floor of the Edison Building, and as the office of the chief operating engineer is here, it was important to have the load dispatcher and all available information at his disposal. A switchboard containing fourteen recording and integrating Republic flow meters and two Bristol long-distance recording pressure gages was placed in the office of the chief operating engineer, and this, together with the telephone, was considered sufficient for the successful operation of the system.

his boilers in and out of service so as to reduce the plant losses to a minimum, but still keep up the required steam pressure, which is quite essential where hydraulic elevator equipment is on the system.

As the weather becomes colder, 24-hour heating is required and the load curve flattens out, giving a high load factor, usually 70 per cent, for the months of December, January and February. A curve showing the average monthly load factor (average load divided by maximum load) for the year is given in Fig. 3. The average yearly load factor for the system is approximately 33 per cent, the maximum half-hour load being at the rate of 220,000 lb. of steam per hour for an annual steam consumption of 633,700,000 lb. From the table it will be seen that the total of the maximum loads for the individual customers is 253,350 lb. per hour, but this is actually reduced in operation to 220,000 lb. per hour, owing to the fact that they do not all occur at the same time of day.

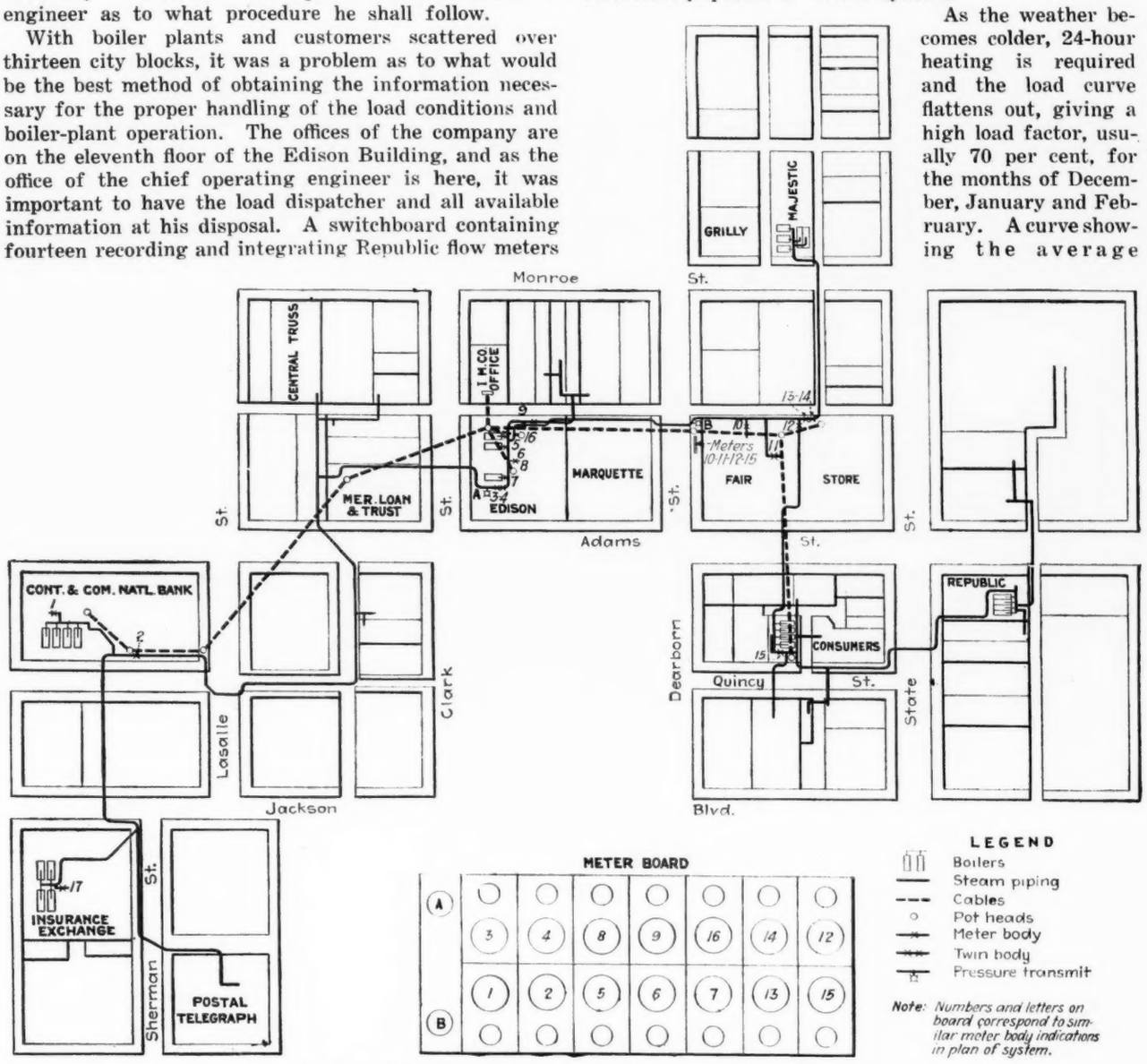

FIG. 1. GENERAL PLAN OF CENTRAL HEATING SYSTEM

Fig. 2 is a series of curves showing the average load on the system for each hour of the day for different outside temperatures. From this it can be seen that during the summer months, when the temperature is 70 deg. F. or warmer, the average day load is approximately 39,000 lb. of steam, but the night load is 1,500 lb. of steam and the load factor for the months of June and July is approximately 50 per cent. A mean daily outside temperature of 60 deg. F. introduces short-hour heating where the customer has heat on in the morning for three or four hours and then cuts it off for the remainder of the day. It is during such period that the load dispatcher must watch his load carefully and get

To make the metering system as flexible as possible and also provide for future extensions and additions, lead-covered telephone cables were run along the main steam lines openly or in conduit, depending upon their exposure to injury. Potheads and terminal boxes (see Fig. 1) were placed at all important points so as to make it easy to connect in any additional meters or gages.

For simplicity the cables are indicated in Fig. 1 as running directly from one point to another, but they actually parallel the steam lines. The terminal box in the basement of the Edison Building has a capacity of

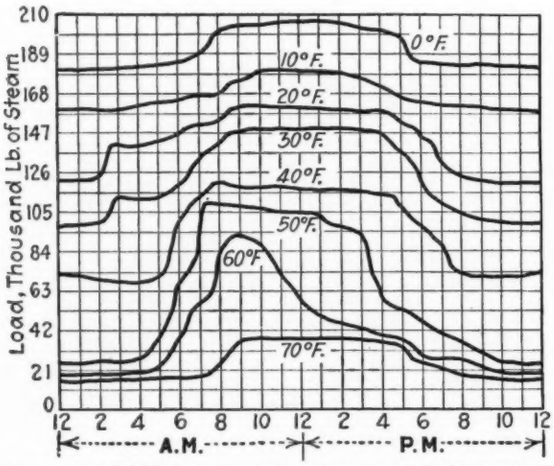

FIG. 2. HOURLY LOAD CURVE FOR VARIOUS OUTSIDE TEMPERATURES

50 pair, and a 50-pair cable extends from there to the terminal cabinet on the eleventh floor. At the present time there are two ten-pair cables and two fifteen-pair cables extending from the Edison basement cabinet to

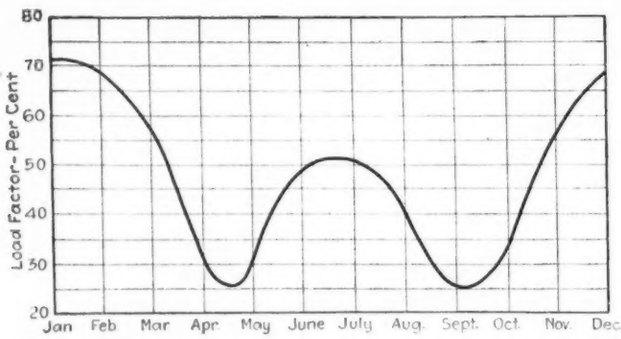

FIG. 3. AVERAGE MONTHLY LOAD FACTORS OF SYSTEM

the Continental and Commercial Bank, Fair Store, Baltimore building and Edison boiler room. The rear of the meter board cabinets for extra transformers and the cable terminal cabinet are shown in Fig. 4.

The flexibility of the metering system made it possible to accomplish many things that were essential for the success of the load-dispatching problem. At certain periods of the day or season the direction of steam flow through a given line may be in one direction, while at other times it may be in the opposite direction. Two such critical points exist in the present distributing system; one in the Edison Building on the 8-in. line crossing Clark Street, which connects with the plants in the Continental and Commercial Bank, and Insurance Exchange Buildings, and the other in the Fair Store on the 6-in. branch, which connects with the plant in the Majestic Building. For the purpose of registering the steam flow at these particular points, twin meter body installations were used (see Fig. 6), two sets of metering instruments being placed on the meter board for each, one meter registering the flow in one direction

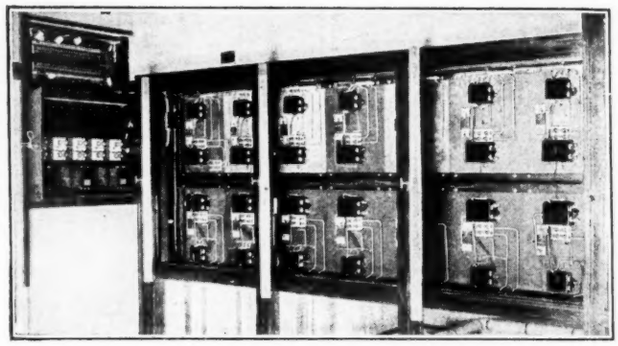

FIG. 4. REAR OF METER BOARD AND AT RIGHT TRANSFORMER AND CABLE TERMINAL CABINETS

and the other registering steam flowing in the opposite direction.

In some cases it was desirous to have duplicate or additional instruments at locations other than the office of the chief operating engineer. For the purpose of assisting the building engineer of the Continental and Commercial Bank in regulating his heating load, a steam recording instrument was placed on the switchboard in his office, it being in series with the instruments on the Illinois Maintenance Co.'s board. Four instruments were placed in the office of the engineer of the Fair Store, as shown in Fig. 5, two of which are duplicate instruments of those in the load dispatcher's office in the Edison Building, while the others were added to enable the Fair Store engineer to regulate his

DATA ON THE BOILER PLANTS OPERATED AND THE SERVICES TO THE VARIOUS BUILDINGS OF THE SYSTEM SHOWN IN FIG. 1

Building	Volume, Cu.Ft.	Radiation, Sq.Ft.	Max. Load, Lb. Steam per Hour	No. Boilers	Av. Yearly Steam Consumption, Lb.	Steam Service
Baltimore Building	550,000	5,000	4,500	4	10,000,000	Heating, H.W., Cooking
Continental & Commercial Bank	13,000,000	95 000	31,000	4	90,000,000	Heating, H.W., Refrigeration
Edison Building	7,500,000	65,000	19,000	3	36,000,000	Heating, H.W.,
Insurance Exchange	9,500,000	75,000	23,000	4	55,000,000	Heating, H.W.,
Majestic Building	2,000,000	28,000	9,000	5	16,000,000	Heating, H.W.
Republic	3,500,000	30,000	10,000	4	36,000,000	Heating, H.W., Cooking
American Commerce	1,200,000	10,000	3,600		10,000,000	Heating, H.W., Hyd. elev.
Central Trust Bank	1,200,000	6,000	4,000		10,000,000	Heating, H.W.
Chicago Savings Bank	1,500,000	17,000	5,700		15,000 000	Heating, H.W.
Consumers' Building	2,500,000	35,000	9,000		18,000,000	Heating, H.W.
Crilly Building	1,000 000	11,000	6,000		17,000,000	Heating, H.W., Hyd. Elev., Cooking
Fair Store	11,000,000	60 000	13 500		60,000,000	Heating, H.W., Cooking
Great Northern-Majestic	2,600,000	25,000	12,000		35,000,000	Heating, H.W.
Lakeside Building	1,500,000	14,000	3,000		13,000,000	Heating, H.W.
McVickers	1,000,000	10,000	3,600		7,000,000	Heating
Marquette	4,300,000	40,000	14,000		47,000,000	Heating, H.W., Hyd. Elev., Cooking
Merchants' Loan & Trust	2,300,000	26,000	8,600		22,000,000	Heating, H.W.
Peacocks	600,000	6,000	2,000		4,000,000	Heating, H.W.
Postal Telegraph	3,250,000	30,000	17,000		50,000,000	Heating, H.W., Hyd. Elev., Cooking
Spalding	500,000	5,000	2,000		3,000,000	Heating, H.W.
Total of 29 miscellaneous customers	10,000,000	93,800	52,850		79,700,000	Heating, H.W., Cooking
Total	80,500,000	686,800	253,350	24	633,700,000	

Boilers in these buildings not used

steam service. As a guide to the firemen in the boiler room of the Edison Building indicating instruments are installed alongside each boiler.

The steam-generating plant in the Edison Building being the central plant and the one that it operated at

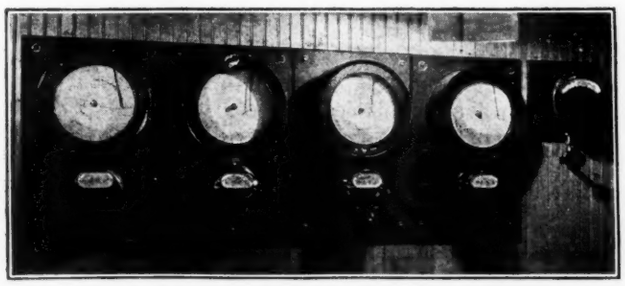

FIG. 5. METER BOARD IN FAIR STORE WITH TRANSMITTER AT RIGHT

full capacity most of the time, meters were placed on the individual boilers. All other meters were placed on main steam lines or service connections with large loads. In this way the necessary information can be obtained with a minimum of instruments. The main meter board

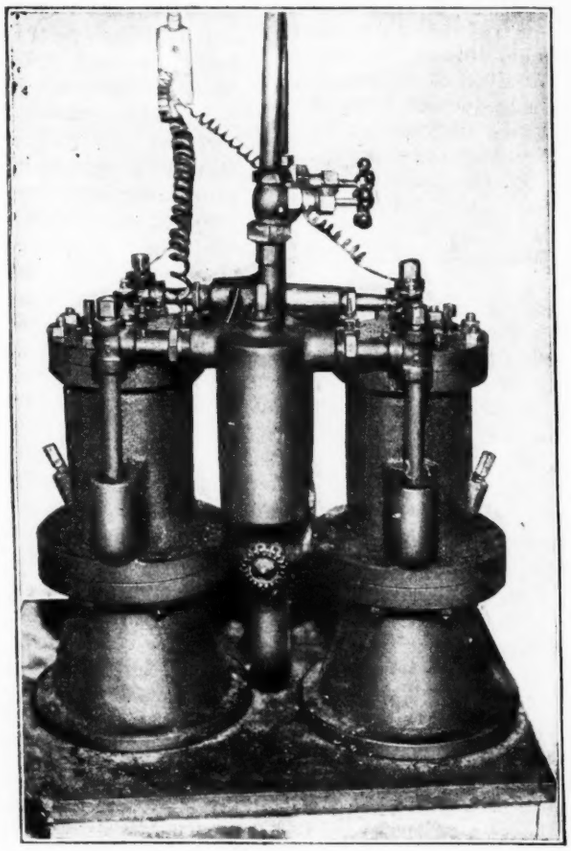

FIG. 6. TWIN BODY METER CONNECTION IN FAIR STORE

located in the chief operating engineer's office, is shown in the headpiece to this article. The instruments are so grouped that the load dispatcher can make his necessary calculations and decisions with the least possible delay. As all steam is transmitted at a pressure of approximately 120 lb. and is used for operating pumping equipment, as well as for cooking, refrigeration, heating water, heating, etc., it is quite essential that a uniform pressure be maintained. For the purpose of checking the pressure and keeping a record of it, long-distance electrically operated pressure gages are connected at two of the more critical points in the system and the recording instruments placed where they will be in view

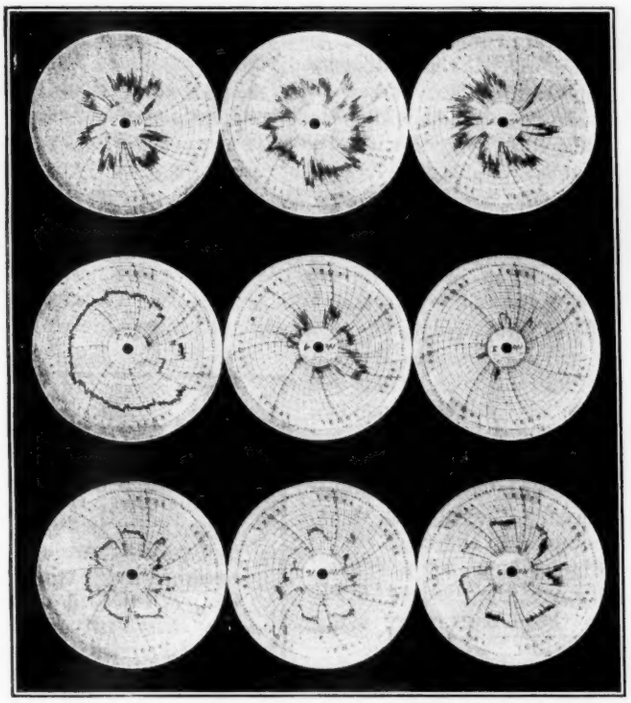

FIG. 7. TYPICAL CHARTS TAKEN FROM RECORDING FLOW METERS IN CHIEF OPERATING ENGINEER'S OFFICE

of the load dispatcher. The recording instruments are all equipped with seven-day clocks and seven-day charts are used.

A few typical charts are shown in Fig. 7. The clocks in the flow meters operate electrically from the master clock of the Edison Building. This eliminates the winding of clocks by hand, and the seven-day chart reduces the changing of charts to a minimum. For accuracy the recording instruments are read each hour during the critical periods of the day. The load dispatcher collects and compiles all data, posting the load curves hourly, so that the chief operating engineer may know what is going on in the system at any time.

The temperature of the air in the engine room has much to do with the proper feeding of the oil from the oil cups. If sight-feed cups are used and the temperature of the room is 90 deg. when the feed is regulated, and if the weather should turn cool and the windows be left open too long, allowing the temperature of the engine room to drop to, say, 60 deg., the oil in the cups will become thick and will not feed fast enough and the result very often is a hot bearing. Cylinder hydrostatic lubricators are affected by lowering temperatures, because, although they are connected to the steam pipe, the oil in them will become chilled if the temperature of the room gets too low, and consequently they will not feed properly.

The Single-Sheet Lap-Seam Boiler

By J. P. MORRISON
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IT IS probable that no question of machine design has received more careful and intelligent consideration than has the design of the shell seams of steam boilers. Fairbairn's tests were conducted in 1838. W. Bertram conducted tests at the Woolrich Dock Yards in 1860. D. K. Clark discussed riveted seams in 1877. A lap-seam crack was reported in *The Locomotive*, issued in April, 1880, while that publication dealt at considerable length with the stresses occurring in lap seams. On April 17, 1891, J. M. Allen, who was then president of the Hartford Steam Boiler Inspection and Insurance Co., delivered a lecture at Sibley College, in which he gave a complete diagnosis of the various joints then in use, having particular reference to the triple-riveted butt-strap joint. This lecture was published and widely distributed, and the principles set forth are those upon which the calculations of riveted joints, encountered in modern practice, are based. In the early days of steel-plate manufacture the product was confined to sheets of small dimensions. As a consequence the boilers built in those days were composed of a number of courses, and each course, if the boiler was unusually large, would be made up of several sheets. It was not uncommon to encounter a boiler 14 ft. in length and 48 in. in diameter made up of seven courses formed of four sheets each. But as the steel makers became able to produce larger plates, boilers were constructed of a lesser number of courses, each composed of fewer sheets. This appeared to be of considerable advantage in many ways, and when it became possible to produce plates of such size that only two were needed to form the shell plates of a boiler, they found a ready market. With the development in steel manufacturing the importance of the physical and chemical properties of the boiler plates was recognized, particular emphasis being placed on the advantages of great ductility even when obtained at a loss in ultimate tensile strength. Laminations found in steel plate had elicited some criticism, and there was a loud protest at the practice of some steel makers of shipping unbranded plates, for the boilermakers were beginning to realize the necessity of having the steel maker's brand appear on each sheet of the finished boiler. Boiler plates manufactured by both the open-hearth and bessemer processes were used, and it was understood that the quality of the boiler plate depended more upon the grade of raw materials than upon the particular process.

Difficulty that had been experienced by reason of girth-seam leakage, fire cracks and mud burns, all attributed to the sediment within the boiler accumulating against the girth-seam laps, gave added attraction to the idea of rolling one sheet to form the bottom half of the boiler. The upper half continued in some cases to be constructed of two or three plates, while in other cases one large plate only was used. This form of construction necessitated the use of a longitudinal seam on each side of the boiler extending from head to head, and was confined to shops having plate-bending rolls of sufficient length to pass a 16-ft. or 18-ft. sheet between housings.

It is worthy of note that this construction was criticized twenty-five or more years ago, and subsequent developments have proved the correctness of those who, while without sufficient facts at hand to justify outright condemnation of the single-sheet boiler, brought its weaknesses to public attention and withheld approval, citing the explosion of one boiler due to the single bottom sheet construction, and which resulted in the loss of two lives and an estimated property damage of $5,000. Those unacquainted with shop practice of the older days will hardly realize the possible damage done to a sheet during the process of fabrication of the boiler. The rivet holes were punched full size, except where special requirements were to be met, so the mill cracks started by the punching process were not removed. Few of the shops were equipped with a press to shape the ends of the sheet to the proper curvature. The work was done by placing the sheet over a rail or one of the bending rolls and sledging the edges, often stressing the questionable material beyond its elastic limit along the line of rivet holes in the second row, where the sheet had already been weakened by the reduction of the metal and by mill cracks, due to punching the rivet holes. To this were added the stresses set up when the poorly fitting joint was bolted up and later riveted. Usually, the joint was then sledged into shape for calking.

The single-sheet lap-seam boiler, so destructive of life and property, must go. An analysis of its weaknesses is evidenced by numerous explosions. It does not possess a sufficient margin of safety, is made of questionable material, is subject to injuries during the process of fabrication, is impossible of thorough inspection, and in operation is stressed beyond the safe limit by temperature difference, by lack of girth-seam support and by the unequal distribution of the weight of the boiler, contents and connections.

Fig. 1 indicates the change in shape of the ends of a plate when being formed over the roll by the use of the sledge. Fig. 2 illustrates the condition of the ends of the plate, after the rest of the plate has been rolled to the proper curvature. The ends, having been shaped by blows of the sledge, do not conform to the true curvature. That was also the era of the drift pin, when an unfair hole could be made fair, adding more stresses to the sheet along the line of rivet holes.

Even then the trend of the times was toward boilers of larger diameter. Since the size of the plates obtainable would not permit locating the head-to-head seams above the horizontal diameter, the seams of such a boiler were exposed to furnace temperatures, in addition to the stresses due to difference in temperature of the upper and the lower section of the boiler, the former being exposed to the atmosphere, while the latter was subjected to furnace heat as indicated in Fig. 4. The intensity of these stresses would vary con-

siderably, but one authority has reported them as amounting to approximately 6,000 lb. per square inch.

The never-ending effort of the contained pressure to perform the impossible feat of rounding out the irregular surface existing at the lap seams produces the lap-seam crack, for which this joint is notorious. In Fig. 3 *x* and *z* indicate the development of such a crack, while

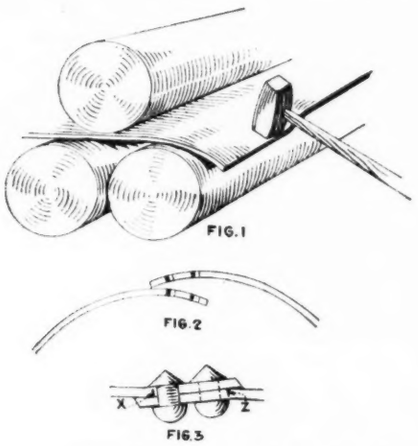

FIG. 1. FORMING END OF PLATE OVER ROLL
FIG. 2. ENDS OF PLATE TO BE SLEDGED TO SHAPE
FIG. 3. LAP SEAM STRESSED TO FAILURE

Fig. 5 shows a crack that developed in a plate in service. Furthermore, this lack of symmetry renders the plate along the line of greatest stresses susceptible to corrosive action, which would be intensified where there were three pairs of supporting brackets, as was the case with large boilers; and the settling of the furnace walls at the front or rear transferred the load, amounting to one-half the weight of the boiler and contents, onto the center bracket.

The strengthening effect of the girth seam has been the subject of considerable discussion. It is in principle quite the same as applying a hoop to the circumference of the boiler. This is evidenced in a number of instances when, upon the vessel being stressed beyond the elastic limit, the increase in circumference did not even extend to the girth seam, owing to the hoop effect of the seam. The fact that the explosion of a two- or three-course boiler, due to lap-seam failure, rarely results in a rupture extending across a girth seam should leave no need of further argument in favor of a construction embodying girth seams.

Before the double-strapped butt joint was universally adopted, a large number of lap-seam boilers, many of them of the single-sheet variety, were placed in operation. The majority of these boilers were intended for 100 lb. pressure, using a factor of safety of 4. This factor has been generally recognized as inadequate, even for boilers of superior construction, and could not be expected to be continued as satisfactory for lap-seam boilers after a few years of service and abuse.

After considering the various factors having a direct influence on the safety of single-sheet boilers, it does not appear strange there have been so many violent explosions, with the loss of numerous lives and property damage approximating a million dollars in value. The facilities for investigating boiler explosions were probably not in keeping with the general industrial activities, but in the early days, when 80 to 100 lb. pressure was considered high, each explosion was more or less shrouded in mystery, and the theories advanced as to the cause were about as intricate and vague as could be imagined. The presence of a super-gas, the spheroidal state of the water, the geyser action of the water, superheated water, low water or no water, inflammable steam and the presence of a vacuum were theories, each of which had its following. The cause of the difficulty, the single-sheet lap-seam crack, was generally overlooked by investigators seeking to establish the correctness of their pet theory as to the force, or phenomena causing the destruction. A few engineers realized the influence of manufacture on boiler safety. Zera Colburn is quoted as stating in 1880, "All our knowledge of boiler explosions goes to show that in the majority of cases the actual explosion results from some defect, either original or produced, and either visible or concealed, in the material, workmanship or construction of the boiler."

There is no complete list of explosions of single-sheet boilers nor of the number that have been found to be unsafe and discarded from service, but the record available is sufficient to indicate clearly the unusual hazard attending the operation of boilers of that description. The condemnation of a boiler having a seam

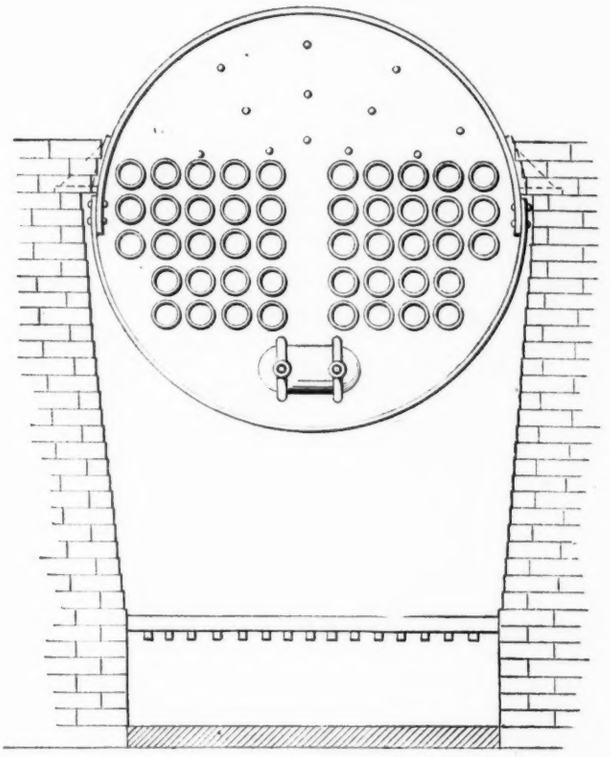

FIG. 4. SEAMS OF SINGLE-SHEET BOILER INACCESSIBLE AND EXPOSED TO FURNACE HEAT

crack 14 ft. in length was recorded in 1894, and on Feb. 1, 1895, a boiler 66 in. in diameter by 16 ft. long, containing 54 four-inch tubes, and constructed of steel plates $\frac{3}{8}$ in. thick, forming a single course of the bottom of the boiler and three courses of the top, exploded in an electric-light plant with disastrous results. One man is reported to have been killed, three others seriously injured, and the power plant totally wrecked. The line of failure followed the seam from the head two-thirds of the length of the boiler, from

which point separation occurred, the girth seam being followed across the top of the boiler by one branch of the crack, and the other extending through the solid plate downward toward the rear. The boiler had three pairs of supporting lugs, and conditions indicated that the initial failure occurred under the middle lug.

The Rochester, N. Y., Brewery explosion followed in 1899, and caused the death of one man, as well as property damage estimated at $25,000. On Nov. 26, 1901, a disastrous explosion of a 66-in. by 16-ft. boiler

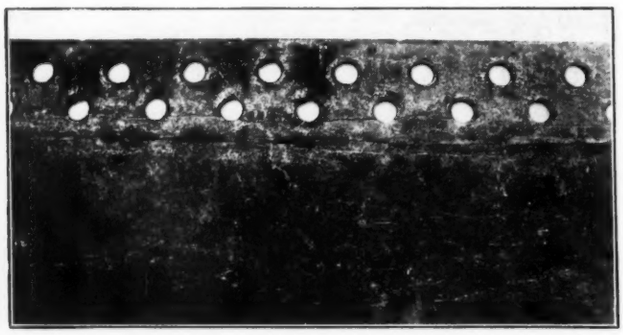

FIG. 5. A LAP-JOINT CRACK

at the plant of the Penberthy Injector Works, Detroit, Mich., demolished a three-story brick building and cost the lives of thirty and seriously injured thirty-five others. The total property damage was estimated at $100,000. This boiler had seen but six or seven years of service and was understood to be in good condition. The line of failure followed the longitudinal seam on one side of the shell, substantially in a straight line from one head to the other.

Of a single-sheet boiler the next violent explosion of which record is available, occurred at the plant of the American Tin Plate Co., Canton, Ohio, on May 11, 1910, and was reviewed in the issue of *Power* of May 31, of that year. Then followed the Midvale, Ohio, explosion and the Shelton, Conn., explosion in 1911; the Pleasant Valley, Conn., explosion in 1915; the Athol, Md., explosion in 1916, and the Cross Run, Pa., explosion in 1917; all bearing the earmarks of lap-seam defects and occurring to single-sheet boilers, taking the usual toll in life and damaged property.

While the Fargo, Tex., explosion, occurring on Oct. 1, 1914, was caused by a lap-joint failure of a single-sheet boiler, it differed materially from some of those previously mentioned, inasmuch as the boiler had been carefully examined by an expert inspector and pronounced unsafe to operate, his opinion being based on the corrosion which had attacked the longitudinal seam. These seams were not visible on account of their location below the upper tubes, but after cleaning those parts as thoroughly as possible, the inspector determined by his finger tips that there had been so much reduction in thickness that there was not sufficient strength to withstand the pressure. However, the owner placed the boiler in operation, and the second day thereafter it exploded, killing two men, injuring two others and wrecking the plant. Investigation developed the fact that the rupture had occurred in the outer sheet of the lap, that sheet forming the bottom half of the boiler, as is common with single-sheet construction, and followed a line parallel to the edge of the inner lap, extending from head to head through metal which, owing to corrosion, did not average $\frac{1}{8}$ in. in thickness.

The accompanying photographs, Figs. 6 to 8, illustrate the damage done by the explosion of a single-sheet boiler, which resulted in the death of two workmen, the serious injury of two others, and the total destruction of the plant. Fig. 6 gives a good idea of the general damage to the plant, and Fig. 7 is a close-up view of the boiler tubes and head. The boiler was said to have been about 24 years old, and its builder was unknown, as it had been used elsewhere and had changed owners a number of times. So far as could be learned, the boiler never had been subjected to an examination by anyone qualified to pass judgment in such matters. The double-riveted lap seams extended from the front head to the rear head on each side of the boiler. The means of support consisted of three pairs of cast-iron brackets resting on the furnace walls, one being between the dome and longitudinal seams, on either side of the boiler. The pressure carried at the time of the explosion was 100 lb., and it was probable the builder sold the boiler when new with the customary guarantee of that pressure, which would be permitted by a factor of safety of 4.

Some time previous to the accident leakage was observed at the longitudinal seam under one of the center support brackets. A boilermaker of questionable ability and experience patched the seam as indicated by the arrow in Fig. 8, apparently without giving thought to the cause of the difficulty, but riveting the patch at the boiler seam and using patch bolts for securing the new seam. The boiler was continued in operation without further trouble until about a week before the explosion, when seam leakage was again

FIG. 6. RESULT FROM THE EXPLOSION OF A SINGLE-SHEET BOILER

observed. The mill superintendent and an employee are said to have drilled and threaded for $\frac{3}{4}$-in. capscrews, four holes along the seam where leakage had appeared. A soft patch consisting of a sheet of plow steel and a thin sheet of lead was secured to the boiler by means of capscrews and nuts, and the boiler was again placed in service.

The failure occurred in the sheet forming the lower part of the boiler, on a line coinciding with the edge of the inner lap, just about the same location as in the failure of the Fargo, Tex., boiler, and did not follow nor enter the rivet holes. It extended the entire

length of the seam, as is customary with violent failure of this kind. The rivets in the head seams either sheared at the junction of the plates or the rivet heads pulled off, as none of the rivet holes were destroyed, although some of them were found to be considerably elongated.

After an accident, where there are so many possible causes, it is difficult to define responsibility. In this case the center bracket above the point where the initial leakage and crack developed, most likely supported the entire weight of that side of the boiler, which, as has been outlined, would follow from the settling of the furnace at the front or back bracket, and would clearly justify the modern requirements which provide for four-point suspension only. The factor of safety was not one-half as great as considered necessary by good authorities for boilers of such great age and design, and had a proper factor of safety been maintained, the explosion would not have occurred, as the pressure permitted then would not have been sufficient to operate the plant, and the boiler would have been scrapped.

Had the service of the boiler been limited to ten years, as has been advocated for the lap-seam boiler, its use would have been abandoned years before. The owner no doubt would have experienced some financial loss, but nothing compared to the loss resulting from the explosion. Had the boilermaker who patched the boiler been acquainted with developments of recent years, so far as boiler design and safety are concerned, and the rules which prohibit repairing a boiler in which a lap-seam crack has developed, or had the mill superintendent realized the clear danger warnings and discontinued the boiler from service until the advice of competent persons could be obtained, there would have been no explosion. This accident emphasizes the difficulty of obtaining proper co-operation of boiler

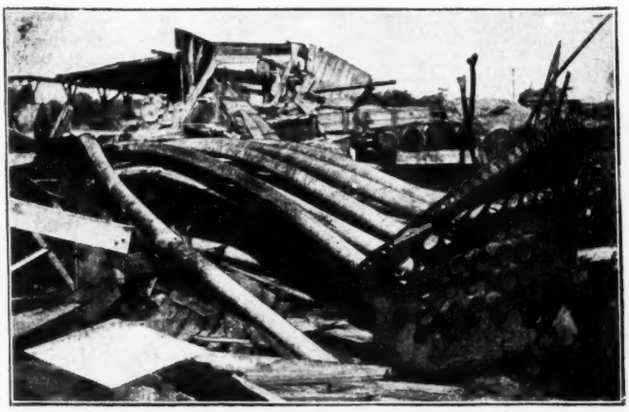

FIG. 7. CLOSE-UP VIEW OF BOILER TUBES AND HEAD

owners in enforcing reasonable rules and regulations, as the boiler was being operated without a certificate from the state authorities, who had no knowledge of its existence, and it is doubtful if the owner and those in charge of its operation knew that the boiler differed in any material way from new boilers of modern design.

Fortunately, the installation of new boilers of this description is prohibited in many states and cities, so its manufacture practically has been abandoned, but there are a great number in operation, and the next few years may witness an increasing number of failures, as the defects, undoubtedly existing, develop until rupture takes place. An increase in the factor of safety will result in a reduction of pressure; this may cause the removal of the boiler from its present place of operation, to be disposed of, if there are no restrictions, through dealers in second-hand boilers, only to be placed again in service, to the jeopardy of someone's life and property.

In discussing the Cross Run, Pa., explosion, *The Locomotive*, in the July, 1917, issue, asserts: "The

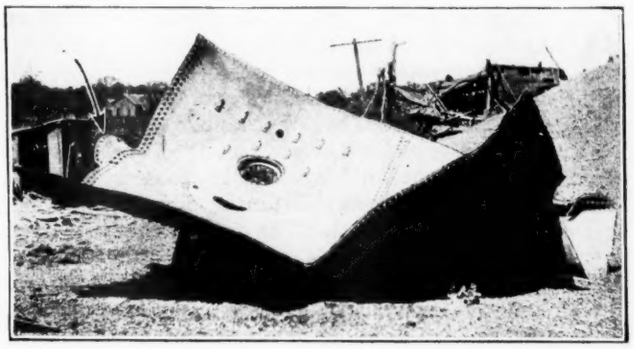

FIG. 8. SHELL PLATES BLOWN FREE OF THE ENDS AND TUBES

lap-seam boiler has been a fruitful source of steam-boiler accidents in this country, and of lap-seam boilers perhaps no class has been more subject to disaster than those made in a single course with two sheets, one above and one below." It is evident that the single-sheet boiler "has been weighed in the balance and found wanting." It has sustained injuries during the process of fabrication, is impossible of thorough inspection, has been stressed beyond its safe limit by temperature difference, by continual flexure due to nonconformity to a true circle, by lack of girth-seam support, and by the unequal distribution of the weight of the boiler, contents and connections.

Shall those boilers now in use be continued in service, to change owners and operating conditions at will, until each gives positive and direct evidence of its worthlessness by exploding, with the aggregate loss of another hundred of lives, and of another million-dollar property damage? Or shall the rule against habitual criminals be invoked, and each boiler of that type sentenced permanently to the scrap yard, where it will have no further opportunity to destroy, just as the police character, in whom the bad outweighs the good, is given an indeterminate prison sentence, so he can do no more injury to society? If those financially responsible for the continued operation of single-sheet boilers could be made to realize that immediately preceding each lap-seam boiler accident the owner considered his boiler perfectly safe to operate; or appreciated the fact that under certain circumstances any person might be the victim, as our sidewalk basement boiler rooms, hotel power plants and department-store power plants, if they do not contain unquestionably safe equipment, place the lives of all in jeopardy; or realized that defective boilers endanger the lives of the employees to whom the employer owes the moral responsibility of furnishing safe tools—then there is no question that the verdict would be, "The single-sheet boiler must go."

Standard Fuel-Oil Vertical Two-Stroke-Cycle Diesel Engine

A Vertical Two-Stroke-Cycle Port Scavenging Diesel—Scavenging Air Handled by Stepped Pistons—Plunger Type Fuel Pump Under Direct Control of Rites Governor—Fuel Consumption of 0.455 Pound Per Brake Horsepower from 10¾-Inch Cylinder

ALTHOUGH in the past a more general recognition has been given to the four-stroke-cycle Diesel engine, in recent years a considerable number of engine builders have taken up the manufacture of the two-stroke-cycle type. That the failure of the early two-stroke-cycle engines has not deterred these firms is ample proof that this cycle does possess certain merits that give it, in many instances, advantages over the four-stroke-cycle Diesel. The failure of the early experimental two-stroke-cycle engines can be traced directly to the inexperience of the builder and designer. With greater design and manufacturing experience the troubles which were believed to act as bars to the commercial development of the engine have been removed.

Among these advocates of the two-stroke-cycle principle is found the Standard Fuel Oil Engine Co., Bucyrus, Ohio, which for the last seven years has built horizontal two-stroke-cycle Diesel engines in sizes from 50 to 200 hp. The performance of these machines has, the builders feel, fully justified their faith in this principle, and they are at present engaged in enlarging their field by the development of a line of vertical engines to be built in sizes from 100 to 1,000 hp. for both stationary and marine service. A two-cylinder 100-hp. engine of this new vertical type, which is shown in Fig. 1, has been in operation on the company's test floor for the last six months. Extensive tests have shown that this engine compares most favorably with four-stroke-cycle engines of similar power As will be noticed from Fig. 2, a box type of frame is used, but on account of the heavy through bolts between cylinder flanges and baseplate, this member is not subjected to tension strains. Very liberal width of openings can, therefore, be provided for inspection and adjustment of bearings. The baseplate is a box section and of such depth that the crankpit does not come below the bottom of the base. The main bearings consist of cylindrical cast-iron shells lined with babbitt. They can be rolled out without lifting the crankshaft, which is of very liberal dimensions, being of 6¾ in. diameter for a working cylinder of only 10¾ in.

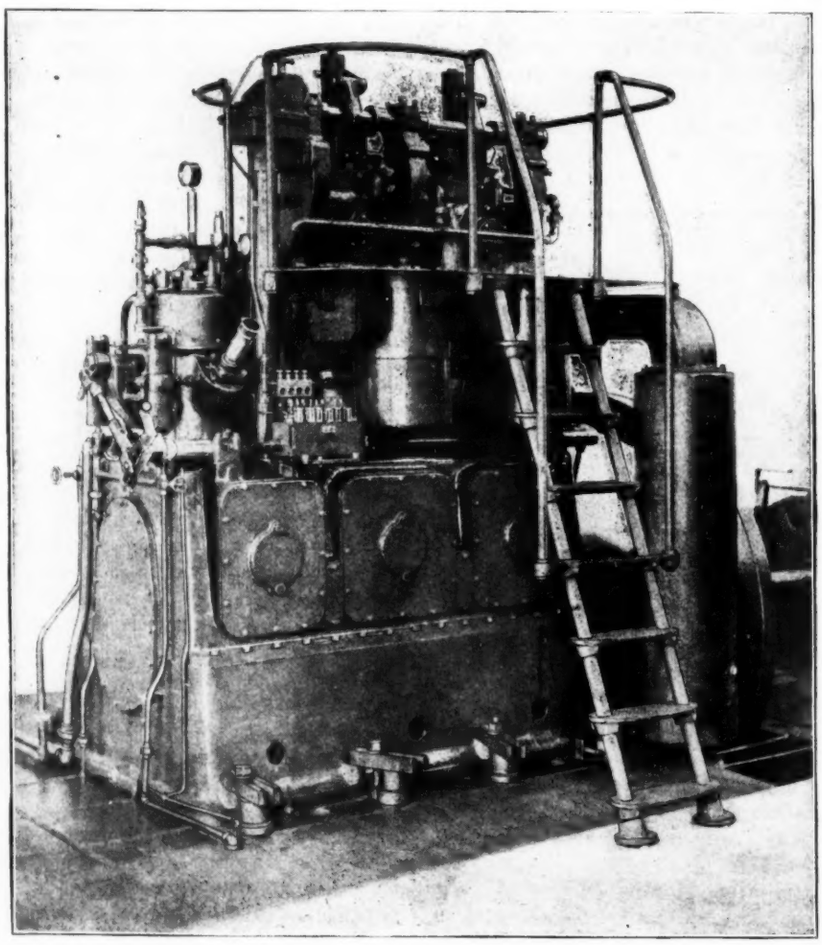

FIG. 1. STANDARD FUEL-OIL VERTICAL TWO-STROKE-CYCLE DIESEL

The port scavenging system is employed, resulting in a cylinder with but one working valve, and this but a small ½-in. needle valve for controlling the injection air which sprays the fuel into the combustion space. For furnishing the scavenging air for cleaning and filling the main cylinder, a stepped piston is used, which is shown in Fig. 3. As this enlarged portion of the piston carries the piston pin, it also performs the duties of a crosshead and relieves the main cylinder wall of the connecting-rod thrust. The pin bearing operates at a low temperature, being removed from the hot piston head. The main piston being relieved of the heavy bosses for carrying the piston pin, becomes a symmetrical member much better fitted to resist the pressures and temperatures to which it is subjected. The scavenging air pressure is very low, slightly less than two pounds. Ac-

cording to the designer of the Standard engine, C. M. Blanchard, the use of such low pressures not only greatly reduces the work of compressing the scavenging air, but also results in a much-improved scavenging, as there is less eddying and tendency to mix the incoming pure air with the exhaust gases. In the Standard engine the cylinder head is free from all opening save that of the fuel valve and is so shaped as to result in a combustion space in the form of a cone with the fuel valve located at the apex. This combustion space, conforming closely as it does to the shape of the spray issuing from the fuel valve, insures rapid mingling of the fuel with its air for burning and makes very materially for early and efficient combustion.

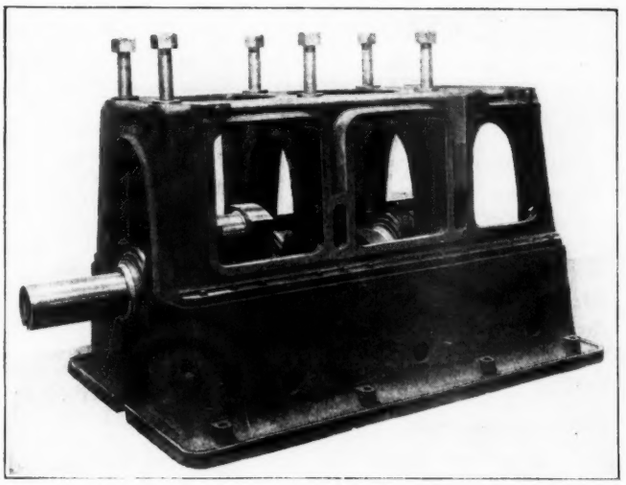

FIG. 2. ENGINE FRAME

For engines of 200 hp. and below the injection air is furnished by a two-stage compressor. As may be seen from Fig. 4, this is very completely water-jacketed, both cylinders and valve pockets. For each stage the suction and discharge valves are mounted in a single cage, the suction being of the poppet type and surrounded by a plate-type discharge valve of comparatively large diameter but very limited lift. As the high-stage valve unit is located in the end of the cylinder, there results a simple cylinder casting with but one valve pocket. Fig. 4 shows very clearly the location of the inter- and after-cooler coils in the water-jacket space. The speed of the engine is controlled by a Rites inertia governor; this drives the fuel-pump plungers, varying the stroke in accordance with the load. The engine does not require high-pressure air for starting, but employs a pressure not to exceed 200 lb. While a small high-pressure bottle is provided for equalizing the injection pressure between the different cylinders, it is so arranged that this need not be filled until the machine is in operation.

Lubrication of the main and air-compressor cylinders is taken care of by a forced-feed lubricator. For the remainder of the machine there is provided a continuous oiling system which allows a steady stream of cool, filtered oil to be fed to each bearing. Oil is delivered to the crankpins by means of a centrifugal ring and from there passes up through the drilled connecting rod to the piston-pin bearing.

The first two charts in Fig. 5 show average Diesel-

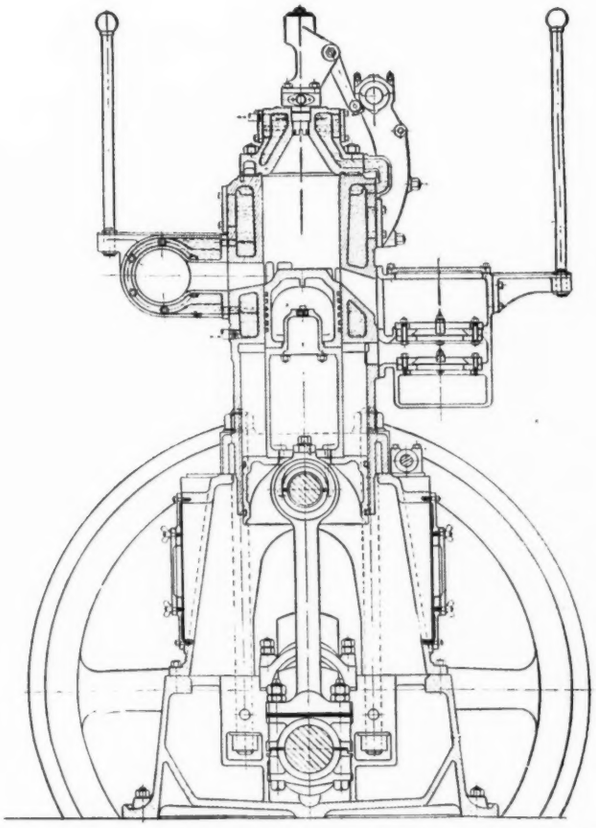

FIG. 3. CROSS-SECTION THROUGH WORKING CYLINDER

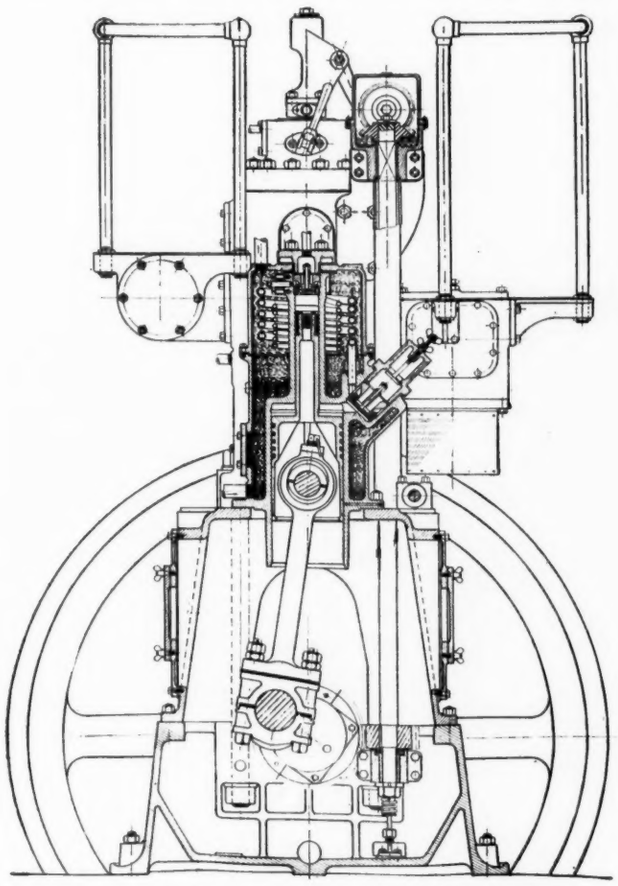

FIG. 4. CROSS-SECTION OF AIR COMPRESSOR

engine practices for both the two- and four-stroke-cycle types, and the third shows the distribution of work in the Standard engine when operated at 250 r.p.m. and rated 50 b.hp. per cylinder. The low percentage of work for operating the scavenging pumps is, as already mentioned, largely due to the employment of an exceptionally low scavenging air pressure. While the reduction in work required for driving the injection air compressor is attributed to a design of atomizer in which not only is the pressure required very moderate, owing to a minimum number of restricted passages, but also the volume of injection air required is considerably reduced. The slightly lower mechanical losses are explained by the ideal conditions, both as to temperature and lubrication, under which all bearings and rubbing surfaces operate.

In Fig. 6 are reproductions of indicator diagrams taken at various loads with the engine operating at

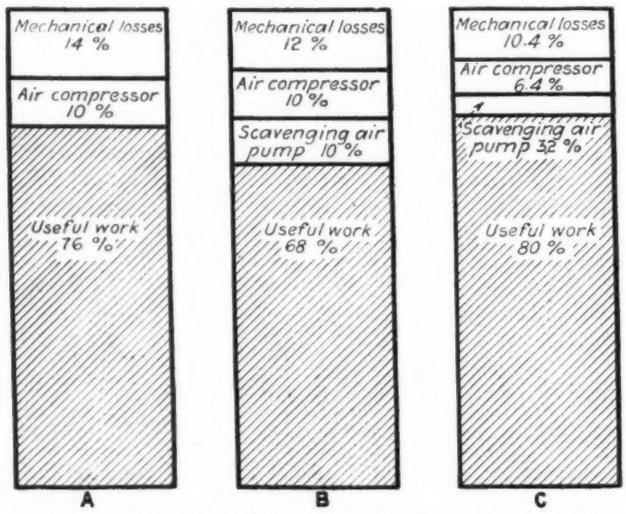

FIG. 5. COMPARISON OF MECHANICAL EFFICIENCIES
A, usual four-stroke-cycle Diesel; B, two-stroke-cycle Diesel; C Standard two-stroke-cycle Diesel.

250 r.p.m. The curves in Fig. 7 show the results of fuel-consumption tests on the 100-hp. two-cylinder machine when operated at different loads and speeds. As would be expected, owing to the longer time allowed for combustion and the slightly higher mechanical efficiency, somewhat better results are shown at the lower speeds. However, that the difference is as slight as shown, speaks very well indeed for the perfection of the design as to these two features.

When comparing these fuel-consumption figures with others published, it should be borne in mind that they are for a cylinder of but 10¾-in. bore. For a cylinder of twice this diameter, which comes nearer the sizes on which figures are usually found, the results should be nearly 10 per cent lower.

In disapproval of the statement sometimes made that owing to the more frequent power impulses, the two-stroke-cycle engine operates with exceedingly high temperatures, the following figures as to exhaust temperatures of the Standard engine are cited. With the engine in each case developing 100 b.hp., the exhaust temperatures were as follows: At 225 r.p.m., 345 deg. F.; at 250 r.p.m., 325 deg. F.; at 275 r.p.m., 315 deg. F.; at 300 r.p.m., 305 deg. F.

While the temperatures are exceedingly low at all speeds, it is found that for the same delivered horsepower the lowest temperatures result from the more frequent and lighter power impulses rather than the reverse. This, the builders of the Standard engine state, is in accordance with theory and should be the

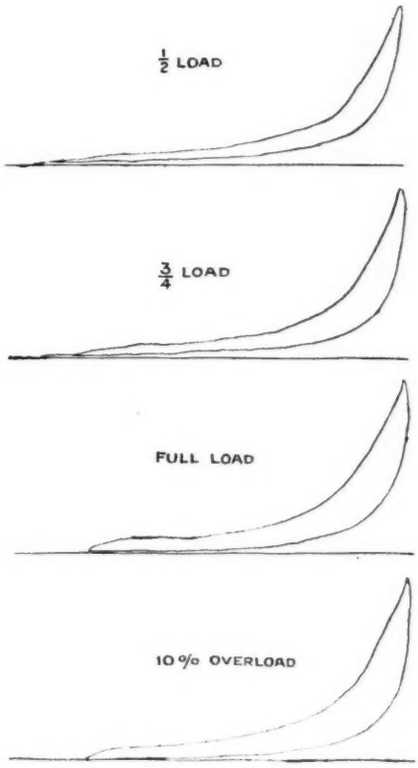

FIG. 6. INDICATOR DIAGRAMS AT VARIOUS LOADS

case for a properly designed machine. For not only does the theoretical efficiency of the Diesel cycle improve as the size of fuel charge is reduced, but there is also a larger volume of cool air passing through the cylinder per unit of time. For the reasons cited they emphasize very strongly the desirability of employing the lighter fuel charges and have adopted ratings requiring mean effective pressures of about 75 lb. as against the usual Diesel practice of 80 to 100 pounds.

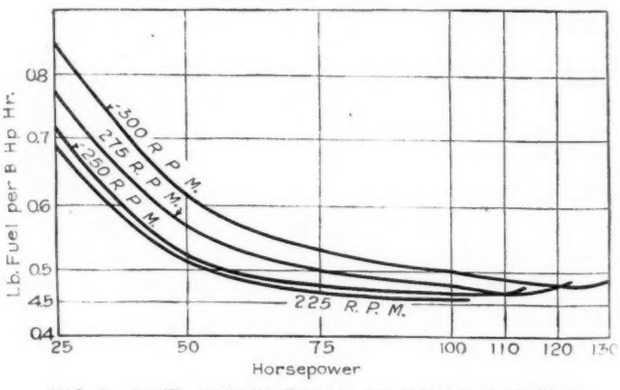

FIG. 7. FUEL CONSUMPTION AT VARIOUS SPEEDS

This, it is contended, is the logical manner for utilizing the admitted advantages of the two-cycle principle and of obtaining a machine which with high thermal efficiency shall also combine the even more important requisite of unfailing reliability.

The Proper Selection of Ammonia Condensers

By W. H. MOTZ*

ONE of the most important steps in the building of an efficient refrigerating plant is the selection of an ammonia condenser adapted to the size and type of refrigeration system. The selection of the type of condenser to be used and the amount of condenser surface to be required depend upon several factors, of which the following are probably the most important: (1) Temperature of water supply; (2) amount of water available; (3) nature and source of water supply; (4) location of condenser and plant; (5) capacity of plant in tons of refrigeration; (6) cost of pumping condenser water.

Removal of Heat by the Condenser

Before observing the effect of these factors on the size and type of condenser to be used, it might be advantageous to investigate the heat-transmission phenomena which underlie the operation of the condenser. The fundamental physical law underlying the operation of the condenser states that heat always tends to flow from a body of higher temperature into a body of lower temperature. The amount of heat removed by a condenser of certain dimensions under given conditions depends on the area of the effective condenser surface, the rate of heat transfer through a square foot of condenser surface in a given time for one degree of mean temperature difference of the ammonia and water, and the mean temperature difference between the ammonia and water. Then, with a given amount of surface (having a certain heat-transfer rate) it is necessary to have a mean temperature difference large enough to produce a flow of heat that will condense the ammonia. This may be more thoroughly appreciated by observing this law expressed in symbols as follows:

$$H = A \times K \times M.T.D$$

in which

H = Heat removed by the condenser, expressed in B.t.u. per hour;

A = Area of the effective condenser surface;

K = Heat transfer coefficient, which is the rate of flow of heat in B.t.u. per square foot per degree temperature difference per hour;

$M.T.D.$ = Mean temperature difference between the ammonia and the water.

In the superheated portion of the condenser the heat flows from a gas to a liquid; in the liquefying part, from a condensing vapor to a liquid; and in the aftercooling portion, from a liquid to a liquid. On account of these conditions the heat-transfer coefficienct for these portions of a condenser have different numerical magnitudes, so that it is evident that the heat-transfer formula must be applied to each portion separately.

Heat Distribution in the Condenser

By noting the distribution of heat in the various parts of the condenser and by observing the mean temperature differences in these parts, the effect of the amount of water available and its temperature upon the selection of a condenser will more readily be understood.

As an example, an ammonia compression system working between 5 deg. (33.79 lb. abs.) and 86 deg. (170.2 lb. abs.) may be taken. The following data cover the conditions before and after liquefaction:

1. Temperature at end of compression, deg. F	213.5
2. Temperature in saturated portion of condenser, deg. F	86.0
3. Temperature of after-cooled liquid, deg. F	76.0
4. Heat of superheating, B.t.u.	82.4
5. Heat of liquefaction, B.t.u.	497.5
6. Heat of after-cooling (to 76 deg.), B.t.u.	11.6

Now, if the condenser water has an initial temperature of 70 deg. and is heated to 82 deg. F. in passing through a double-pipe condenser, the following data may be developed.

	Deg. F
7. Temperature of water at inlet of after cooler portion	70.00
8. Temperature of water at outlet of after cooler portion	70.24
9. Temperature of water at inlet of superheater portion	80.37
10. Temperature of water at outlet of superheater portion	82.00
11. Mean temperature difference, after cooler, M.T.D.A	10.1
12. Mean temperature difference, liquefier, M.T.D.L	9.85
13. Mean temperature difference, superheater, M.T.D.S	40.0

This information is presented graphically by Fig. 1, which is a heat-temperature diagram for a double-pipe ammonia condenser operating under the foregoing conditions of pressure and temperature. The line *ABCD* represents the change of temperature and heat content as the ammonia passes through the condenser. Thus in the superheater portion of the condenser the ammonia is cooled from 213.5 deg. to 86 deg. by the removal of 82.4 B.t.u.; in the liquefier portion in changing from vapor to liquid at 86 deg., 497.5 B.t.u. are extracted; and in the aftercooler portion the ammonia liquid is cooled from 86 to 76 deg. by the removal of 11.6 B.t.u. The line *EFGH* represents the change of temperature and the heat removed by the condenser water. The water rises from 70 deg. to 70.24 deg. in passing through the aftercooler portion, 70 to 80.37 deg. in the liquefier, and 80.37 to 82 deg. in the superheater portion.

Temperature of Condenser Water

With the ordinary amount of condenser water that is available and with a condenser of the usual amount of surface, the temperature of the ammonia must be high enough above the temperature of the water to produce the flow of heat across the condenser surface. This may be appreciated by the inspection of Fig. 1, and the heat transfer formula. The liquefaction portion may be examined as an example. Line *BC* represents the ammonia and line *FG* the water temperature. The mean temperature difference is equal to 9.85 deg. F. Then, by using the heat-transfer formula, the product of this mean temperature difference *M.T.D.* the heat transfer coefficient *K* and the area of the surface *A* will give the total quantity of heat *H* removed by the condenser surface.

Using water at temperatures higher than 70 deg. would elevate lines *BC* and *FG*, and water of lower temperature would depress these lines. The elevation of line *BC* means higher condenser pressures. Generaly speaking, it may be said that the mean temperature differences are diminished in actual practice as the water temperature increases. This means that the condenser using water at a high temperature will have more surface per ton of refrigeration capacity than one using cool water. Under average conditions the temperature of the water leaving the condenser will be from 5 to 10 deg. below the temperature of the

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ammonia in the liquefying portion of the condenser. Generally speaking, it may be said that atmospheric-type condensers are used when only very warm condenser water is available, while the double-pipe type may be used when cooler water is available. This is probably true on account of the fact that there is a smaller temperature difference between the water leaving the condenser and the ammonia in the saturated

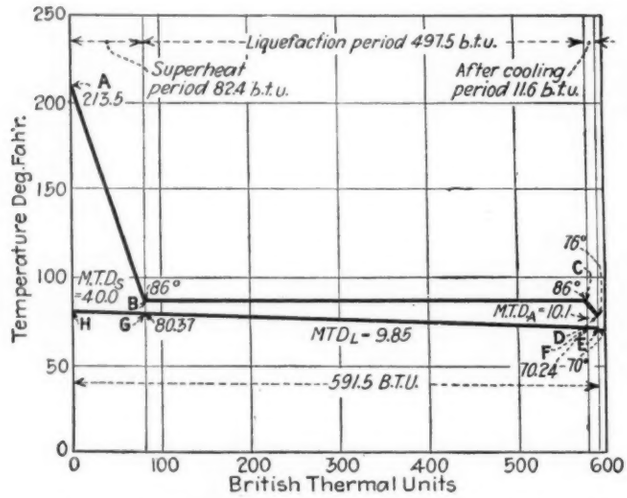


FIG. 1. HEAT-TEMPERATURE DIAGRAM FOR DOUBLE PIPE CONDENSER

portion of the condenser, and a smaller range of water temperature in passing over the surface, in the atmospheric-type condenser. The atmospheric type would then produce the lower condenser pressure.

Amount of Condenser Water Available

With an abundant supply of cooling water the temperature range may be reduced to the minimum, which tends to reduce the condenser pressure. Reducing the temperature range places the line *EH* in Fig. 1 in a more nearly horizontal position. Likewise with the water scarce, the temperature range is greater and the line *EH* rises more sharply. It is apparent that in this case the condenser pressure will be higher.

When the water supply is abundant any type of condenser suited to the plant may be used, but when the water is scarce it may be found advantageous to select the double-pipe type, using a large range of temperature on the water.

The great benefit of evaporation with the atmospheric condenser is that it reduces the range of the water temperature. This in turn reduces the temperature of the condensing ammonia, which results in reduced condenser pressure.

It must be remembered that there are three important factors that affect the condenser pressure which may be obtained in any plant; namely, the amount of effective condenser surface, the temperature of the water supply and the amount of water available for condensing purposes. The installation of a large amount of condenser surface is to be advocated for almost every plant. The installation of an additional amount of condenser surface is a question of initial cost, and the saving that is obtained by a reduced condenser pressure is, of course, a continual one.

The water for the condensers is taken usually from one of the following sources: (1) Deep wells; (2) rivers, lakes, or canals; (3) cooling ponds or towers; (4) the sea.

The waters that are pumped out of wells in the earth vary greatly in general makeup, which is especially true of the mineral matter content. Water containing a comparatively large amount of the dissolved minerals is commonly termed "hard." Now, these hard waters, upon being heated as they pass through or over a condenser, may deposit scale or sediment on the condensing surfaces.

The method of pumping also has a bearing on the precipitation of mineral matter from the water. A large amount of solids may be deposited by hard waters that are pumped by means of the air-lift pump. This is especially true if an air separating tank is not installed.

From the foregoing the conclusion may be drawn that if scale is deposited by hard water below 100 deg. F., it is necessary to use the atmospheric types of condenser. The scale may be easily removed from condensers of this type. If the water is not very hard and deposits only a soft sediment or film of matter below 100 deg. F., the double-pipe type condenser may be used.

Water taken from rivers, lakes and canals is ordinarily considered "soft"; that is, it contains a comparatively small amount of dissolved mineral matter. On the other hand, the water generally contains a good amount of mud, leaves, bits of wood, vegetable matter and other suspended material. Thus, in using this kind of water in a condenser, the trouble is not so much from the formation of scale as from the deposit

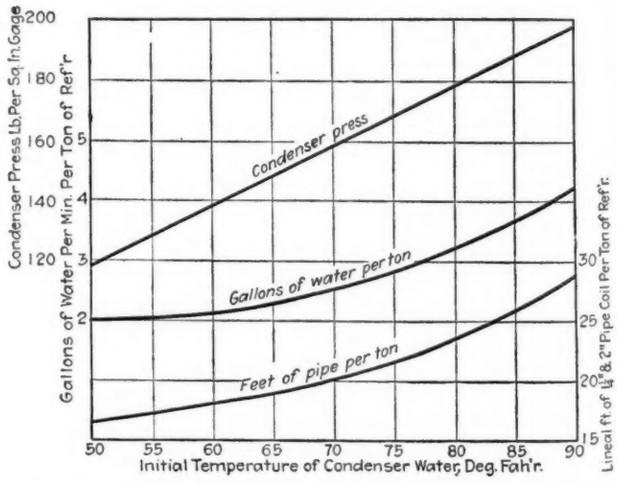


FIG. 2. CHARACTERISTIC CURVES FOR DOUBLE-PIPE CONDENSER

of the suspended matter. Therefore, it is generally desirable to install the atmospheric type of condensers on the plants using this sort of water, in order to facilitate the cleaning process.

Water for the larger-sized refrigerating plants is sometimes recirculated and recooled by pumping it over a cooling tower or through a set of spray nozzles over a spray pond. In this system the water tends to be contaminated with algæ, moss and other organic matter. Although either type of condenser may be used with success, preference is generally given to the atmosphere type, since this type is more easily kept clean. Of course, strainers, screens and other separating devices are

inserted in the pump suction lines to prevent any large pieces of matter from being discharged to the condenser.

Refrigerating plants located along the seashore may well take their condensing water from the ocean. Sea water generally does not throw down a heavy precipitate of scale-forming solids, so that either type of condenser may be used with success. With comparatively cool sea water, the double-pipe condenser gives excellent service under these conditions. While not absolutely essential to the operation of the condenser, it is generally advisable to use galvanized pipes to avoid the corrosive action of the sea water on the condensing surfaces.

Location of Plant and Condenser

The particular locality of the country where the condenser is installed may have a bearing on the selection of the type that could be most efficiently used. It has previously been pointed out that the cooling due to evaporation of a part of the condenser water is of considerable importance. This is especially true in localities where the moisture content of the air (relative humidity) is low. Therefore it is entirely desirable to give the atmospheric type of condenser preference in these localities. In the more humid climates it is often advantageous to use the double-pipe type when it is possible.

The space and relative location of the condenser coils often have a direct bearing on the type of condenser that should be used. When space is available on a roof or the outside of the building, it is feasible to use the atmospheric type for reasons previously indicated. When condensers are installed in this manner, the coils

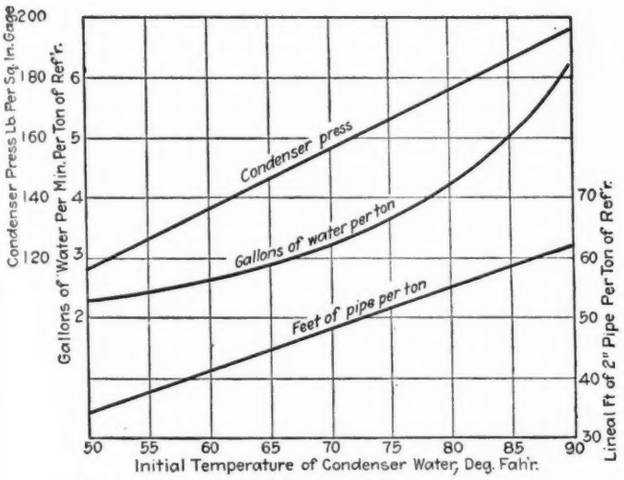


FIG. 3. CHARACTERISTIC CURVES FOR STANDARD ATMOSPHERIC CONDENSER

should be arranged so that the air will have free movement between the pipes, and the pipes should be protected from the direct rays of the sun.

Oftentimes atmospheric condensers are installed in connection with cooling towers and spray ponds. The relative position of the water-cooling apparatus and condenser coils should receive especial attention. These should be placed one above the other and preference should be given to placing the condenser on top, if possible, in order to secure free air movement around the coils, since air must be removed from the spaces between the coils as soon as it has absorbed some moisture, for efficient operation. When it is desirable to place the condenser in the machine room, it is preferable to use the double-pipe type. This eliminates all splash and dampness in the machine room; thus the condenser may be placed in part of the building.

The size and type of the refrigerating plant may be said to affect the type of the condensing apparatus. The following statements may be accepted as general con-

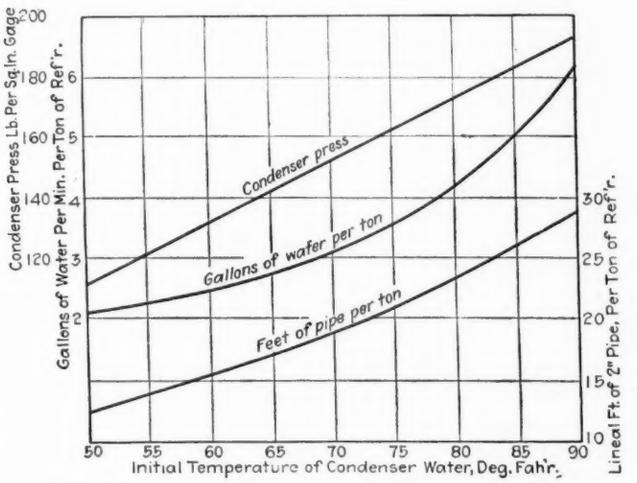


FIG. 4. CHARACTERISTIC CURVES FOR BLEEDER TYPE CONDENSER

siderations, since there is no definite line of demarcation between the various sizes and types of plants that generally require different types of condensers. Generally speaking, atmospheric-type condensers are employed on the medium and large installations. The double-pipe type is usually installed on small plants, while submerged or some special condensers are used on the very small plants.

Surface condensers are sometimes installed when sufficient floor space is lacking and when it is necessary to install a condenser that is easy to erect in place. Generally, surface condensers are installed in absorption plants, in order to match other apparatus.

Economic Considerations

The matter of the proper selection of an ammonia condenser with its water-circulating apparatus is a consideration of economic importance. The condenser and its auxiliaries should be selected with the idea of securing greatest economy over a period of years equal to the life of the condenser. In the ultimate analysis it will be observed that it is desirable to reduce to a minimum the cost of a ton of refrigeration.

If an excessive amount of condenser equipment is installed, the initial cost is very large and a larger amount of cooling water must be supplied. Thus the interest on the additional investment, cost of pumping the larger amount of water, etc., increase the cost of operation. Again, if an insufficient amount of condenser equipment is installed, the condensing pressure will be extraordinarily high, which will result in the expenditure of an excessive amount of work to compress the ammonia. This, of course, increases the cost of power to operate the plant.

Figs. 2, 3 and 4 have been prepared to show graphically how the amounts of surface for double-pipe, standard atmospheric, and bleeder-type condensers vary with the increase of the initial temperature of the condenser

water. Generally speaking, under average conditions these amounts of surface are to be recommended for plants in the United States in order to obtain maximum economy. The charts give the surface in lineal feet of condenser pipe.

Figs. 2, 3 and 4 show the amount of water that should be pumped to the condenser under average conditions. Those figures also show how the quantity of water should vary with the increase of initial temperature of the water.

These figures also indicate the approximate condenser pressure that may be expected with the corresponding amounts of surface and water for the various types of common condensers. The condenser pressure in an actual plant may vary somewhat from those indicated in the figures, which may be due to the general operating condition, such as presence of air in the system, amount of oil in the condenser, etc.

As an example in the use of the charts, let it be desired to select a double-pipe condenser for 25-ton refrigeration, having 60-deg. condenser water. The lineal feet of 1¼-in. and 2-in. double-pipe condenser coil are equal to $18 \times 25 = 450$ ft. If the coils of condensers are to be 20 ft. long, then the number of pipes is equal to $450 \div 20 = 22.5$. Therefore a condenser having 2 sections, 12 pipes 20 ft. long, would be used for this plant. The water required would be equal to $2.1 \times 25 = 52.5$ g.p.m. The approximate condenser pressure would be 138 lb. per sq.in. gage. Likewise a standard atmospheric condenser to condense the ammonia from a 100-ton refrigeration with 80-deg. water would contain $55 \times 100 = 5{,}500$ ft. of 2-in. pipe. A condenser 16 sections 18 pipes high 20 ft. long would contain 5,760 ft. The water required would be equal to $4.25 \times 10 = 425$ g.p.m. The approximate condenser pressure would be, from the chart, 176 lb. per sq.in. gage.

Reducing Gage Pressure to Absolute Pressure

By C. Harold Berry

In reducing pressure-gage readings to absolute pressure, it is necessary to add to the gage reading the atmospheric pressure, as determined by a barometer.

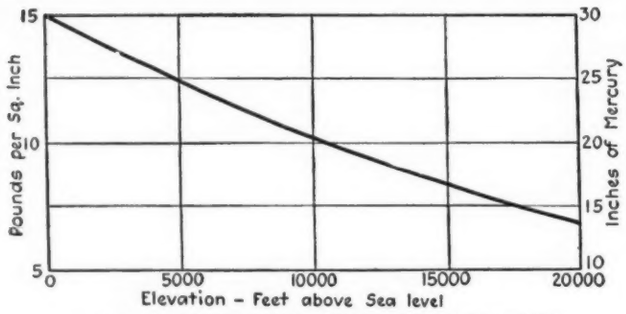


FIG. 1. ATMOSPHERIC PRESSURE VARIATIONS WITH ALTITUDE

One engineering handbook states that for accurate work the actual barometer reading should be used, but that for approximate computations the value 14.696 may be used. The absurdity of such a statement is obvious to anyone who is familiar with the usual types of pressure gages.

The usual gage cannot be read closer than one pound per square inch, and many gages are not reliable to closer than five pounds. Accordingly, it is neither necessary nor proper to determine the atmospheric pressure to a higher degree of accuracy.

For rough and ready results we may use the average atmospheric pressure at the place where the gage is located. This, it should be noted, is not 15, as is commonly assumed, except at sea level. In many places the

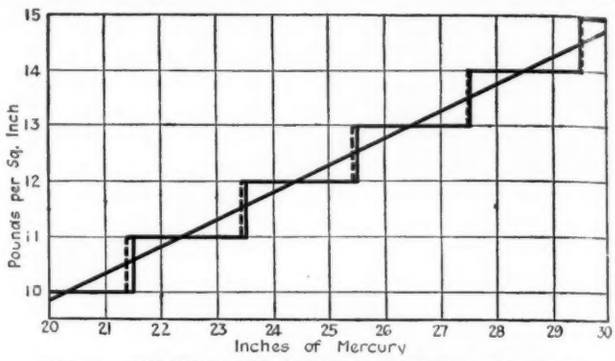


FIG. 2. SHOWING RELATION BETWEEN INCHES OF MERCURY AND POUNDS PER SQUARE INCH

proper figure may be 14, 13 or even less, depending on the elevation above sea level. Fig. 1 shows the relation between elevation and average barometric pressure, with accuracy fully sufficient for this purpose.

For more accurate work we should read the barometer and reduce the reading to the nearest pound per square inch. This is easily done mentally as follows: Read the barometer to the nearest single inch of mercury; divide by two; drop the fraction one-half whenever it occurs. This gives the atmospheric pressure to the nearest pound per square inch. For example, if the barometer stands at 26.73, call it 27, divide by 2, giving 13.5 and drop ½, giving 13 lb. per square inch.

The correctness of this procedure is shown by Fig. 2, in which there are plotted the exact equivalents in pounds per square inch of pressures in inches of mercury, together with the approximate values to the nearest pound per square inch and the values computed by the rule given here. The computed values are shown by the heavy stepped line, and the values to the nearest pound per square inch are shown by the dotted lines. From this it is evident that within certain narrow ranges of pressure the simple mental computation gives results that differ from the true value by slightly over one-half pound per square inch, but that, for work with practically any Bourdon pressure gage, the simple computation may safely be taken as giving the value to the nearest pound per square inch.

For precision observations exact values must be computed by multiplying the inches of mercury by 0.4912, (weight of 1 in. of mercury at 62 deg. F.) after making all corrections for the temperature of the mercury, capillarity, etc.

Uniform Coal Contract Proposed

The form of contract printed on the opposite page is offered by the Fuel Committee of National Association of Purchasing Agents as particularly designed to prevent misunderstandings between buyer and seller.

Prepared as a convenience for its members and the trade in general, it is believed that this form can advantageously be used for most commercial contracts for the purchase of coal, with the addition of special clauses to meet special conditions as may be found desirable.

(This is contract form for coal recommended by the National Association of Purchasing Agents)

Agreement entered into this ..... day of..... 19....., between.....
of ....., hereinafter referred to as Seller,
and ..... of.....
hereinafter referred to as Buyer.

The Seller hereby agrees to sell and deliver and the Buyer hereby agrees to purchase, between the ..... day of .....
19..... and the ..... day of ....., 19....., the quantity and kind of coal and at the price hereinafter stated upon the terms and conditions herein contained, to wit:

QUANTITY ..... net to.

RATE OF SHIPMENT (approximately) ..... net tons per month

DESCRIPTION

Approximate Analysis

PRICE $..... per net ton of 2,000 lbs. f. o. b. cars mines.
POINT OF DELIVERY: f. o. b. cars mines.
TO BE SHIPPED TO.....
DESTINATION .....
ROUTING .....
KIND OF CARS PREFERRED.....

TERMS AND CONDITIONS

1. Invoices shall be paid on or before the.....day of each month for all coal shipped during the preceding calendar month. Non-compliance with said terms of payment shall give the Seller the right to suspend further shipments until all previous shipments are paid for, and if in the judgment of the Seller the financial responsibility of the Buyer shall at any time become impaired and written notice thereof be given by the Seller to the Buyer, the Seller shall have the right to suspend further shipments until adequate security for payment hereunder is furnished by the Buyer. If such security is not furnished within thirty days from such notice, the Seller shall have the right to cancel this agreement.

2. All settlements shall be governed by the actual railroad weights ascertained at the usual points at which railroad shipments from the mine or mines producing the coal shipped hereunder are weighed.

3. Strikes, fires or accidents at the mine or mines where the coal sold hereunder is produced, embargoes, shortage of car supply or other similar occurrences beyond the control of the operator of such mine or mines which prevent or interrupt the shipment of such coal, shall excuse Seller's failure to ship hereunder during the continuance of such occurrence, provided

(a) the Seller is the owner or exclusive sales agent of the mine or mines at which the coal sold hereunder is produced, or prior to or simultaneously with the execution of this agreement has entered into a written contract for the purchase of a sufficient quantity of coal from such mine or mines to fulfill the obligations of the Seller under this agreement;

(b) the name of the owners and location of such mine or mines is stated in this agreement;

(c) the Seller gives the Buyer written notice within five days after such occurrence of the exact nature, extent and probable duration thereof with sufficient detail to enable the Buyer to verify the same;

(d) the total available tonnage of said mine or mines during prevention or interruption of shipments as aforesaid is applied pro rata on all contracts then in force or any renewals thereof for the output of such mine or mines exclusive of contracts or sales made after such occurrence;

(e) Shortage of car supply shall not excuse failure to ship hereunder if at the time of such failure there are in force contracts for the sale of more than the rated output of such mine or mines based on the car rating given such mine or mines at the date of this agreement by the railroads on which the same are located.

4. In case of strikes, fires, accidents or causes beyond the control of the Buyer which wholly or partially stop the works of the Buyer, shipments contracted for shall be suspended or partially suspended as the case may require upon written or telegraphich notice to the Seller.

5. If the Seller shall fail to ship or the Buyer shall fail to accept the monthly shipments herein provided for and shall be excused for such failure under Articles "3" and "4" hereof, the other party at any time after the expiration of the first three months of the contract period may, by written notice to the party who has so failed to ship or accept, reduce the monthly tonnage thereafter to be shipped and accepted hereunder to an amount equal to the average of the monthly shipments for the three months preceding such notice.

6. The purchase price of the coal specined herein is based upon present agreements with mine employees as to wages, and any increase or decrease in the cost of production of the coal shipped hereunder caused by changes in such wage agreements or by the imposition by State or Federal Statute of a direct tax on coal or the mining thereof or subsequent changes in the rate of such tax shall correspondingly increase or decrease said price of coal on any tonnage thereafter shipped hereunder and affected thereby.

7. The coal covered by this contract is to be used only in the plant or plants of the Buyer and is not to be sold or diverted by the Buyer to other purposes without the consent of the Seller.

8. Waiver by either party of any default by the other hereunder shall not be deemed a waiver by such party of any default by the other which may thereafter occur.

9. Notice sent by telegram or registered mail, addressed to the party to whom such notice is given, at the address of such party stated in this agreement, shall be deemed sufficient written notice in any case arising under this agreement.

10. No understandings, agreements or trade customs not expressly stated herein shall be binding on the parties in the interpretation or fulfillment hereof unless such understandings, agreements, or trade customs are reduced to writing and signed by the respective parties.

In witness whereof, the parties hereto have caused this agreement to be executed in duplicate by their respective officers duly authorized the day and year first above written.

..... Seller
By.....

..... Buyer
By.....

Motor Drive for Fans and Blowers

Rotary Blowers and Fans Classified and Described—Limitations, Characteristics in Operation and the Power Requirements—Motors Best Adapted to the Different Types and the Regulation To Use for Speed Adjustment

By GORDON FOX

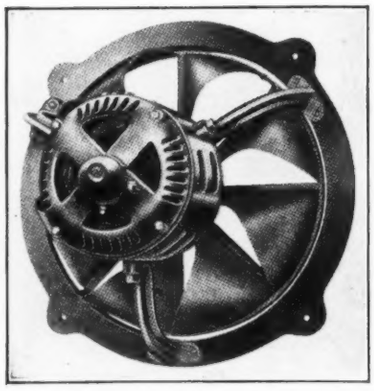


FIG. 1. PROPELLER-TYPE FAN

CENTRIFUGAL fans cover all types in which air is drawn in axially from one or both directions and discharged tangentially by the rotating paddle wheel. Propeller fans are those which discharge axially, the blades being of propeller type. Positive-pressure rotary blowers displace a given volume at each revolution, being similar to rotary pumps. Centrifugal fans are of several types: Plate fans, having flat blades of paddle-wheel type; multivane or Sirocco fans, having a large number of small vanes or blades in a squirrel-cage construction; and volume blowers and pressure blowers, having cast-iron housings of conoidal shape.

Centrifugal fans are utilized for the majority of installations requiring moderate volumes and pressures. They are used in heating and ventilating systems having considerable friction in the piping; for collecting and conveying dust, shavings and other light-weight materials; for furnishing a low-pressure blast for forges, furnaces and cupolas, and for a great variety of other applications. For large volumes at low pressures, propeller-type fans find frequent application as free exhausters and cooling fans. For this service they are preferable to centrifugal fans in that they are smaller in size and cost less. Rotary blowers are used where it is desired to deliver constant volume, regardless of pressure. Propeller fans are used for pressures less than one ounce per square inch. Centrifugal fans are used for pressures below one pound per square inch. The economical range of usefulness of the rotary blower is from a minimum pressure of 10 oz. to a maximum of 12 lb. per sq.in. When sealed by water or other fluid, a vacuum up to 28½ to 29 in. of mercury can be obtained from a rotary vacuum pump of suitable design. Any type of rotary air- or gas-handling apparatus can be either a blower or an exhauster, depending upon whether it is used to drive or draw out air or gas.

The power required to drive any type of fan or blower is a function of the volume and the pressure or vacuum obtained. The formula is,

$$HP. = \frac{K \times Q \times G}{33{,}000 \times E}$$

where

K = Constant = 5.2 for centrifugal fans;
Q = Volume, cubic feet per minute;
G = Water gage pressure, or draft in inches = 1.728 × pressure in ounces per square inch;
E = Efficiency of fan = approximately 40 per cent for steel-plate fans, 48 per cent for multivane fans and 60 per cent for cone-type fans.

For any fan or blower the horsepower varies directly with the density of the gas or air handled; the volume, with free discharge, varies as the speed, and the pressure varies as the square of the speed. Thus the power varies approximately as the product of the foregoing quantities and approximately as the cube of the speed.

The efficiency of a centrifugal or propeller-type fan, having free inlet and discharge, does not vary materially with speed change. Centrifugal fans are rated for a range of speeds, the rated pressure and volume at each speed representing conditions giving best efficiency at that speed. The volume delivered by a centrifugal fan operating at a given speed will vary with the system pressure, and the efficiency will ordinarily be less for volumes other than normal rating, especially for volumes in excess of normal. With a given system pressure the volume delivered by the fan may be increased greatly by speeding up the fan. This is accomplished, however, with considerable loss in efficiency. It is therefore desirable that the rating of the fan should correspond quite closely with the requirements of the system upon which it is to operate.

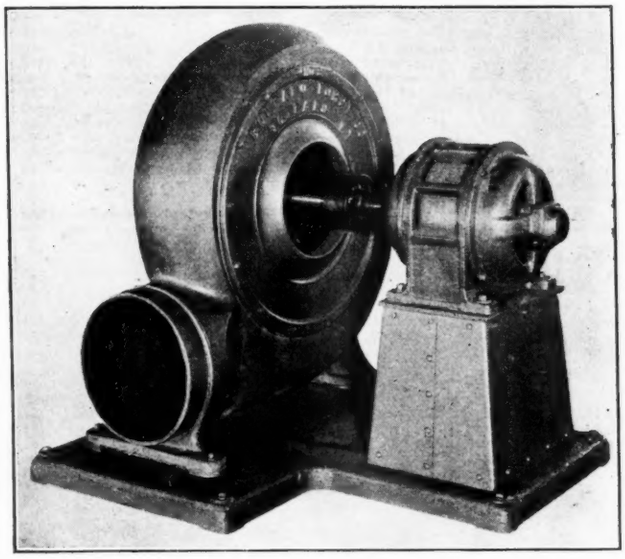


FIG. 2. VOLUME BLOWER

The volume delivered by a positive-pressure rotary blower equals, displacement per revolution × r.p.m. × (1-slip).

For air the slip will run 10 to 20 per cent. For gas the slip may be 25 to 40 per cent, depending upon its density. However, the slip may be no more with gas than with air; for instance, gas containing tar will cause so close a seal that the slip is small. At a given speed the volume delivered is nearly independent of the

pressure. A good rule for determining the power required for rotary blowers follows:

$$HP. = \frac{0.312 \times Q \times P}{1{,}000}$$

where

Q = Volume delivered in cubic feet per minute;

P = Pressure, ounces per square inch.

The efficiency of rotary blowers ranges from 60 to 90 per cent, but falls off with a decrease in speed.

Reduction of inlet or discharge area of a centrifugal fan reduces the power required, the speed remaining fixed. Reduction of inlet increases the pressure, but decreases the volume to a greater degree. At a fixed speed the power consumption of centrifugal fans varies nearly in proportion to the volume of air required. With entirely closed outlet the power required for churning will run 20 to 30 per cent of the power required with an open outlet.

Obstructing the discharge of a propeller-type fan increases the load until it reaches about 200 per cent of the normal value when the discharge is entirely closed. The writer recalls a case in which a number of propeller-type fans were exhausting into a common ventilating shaft. When the fans on the upper floors were started, they effected a partial obstruction to the discharge of the fans on the lower floors, overloading the motors driving these fans.

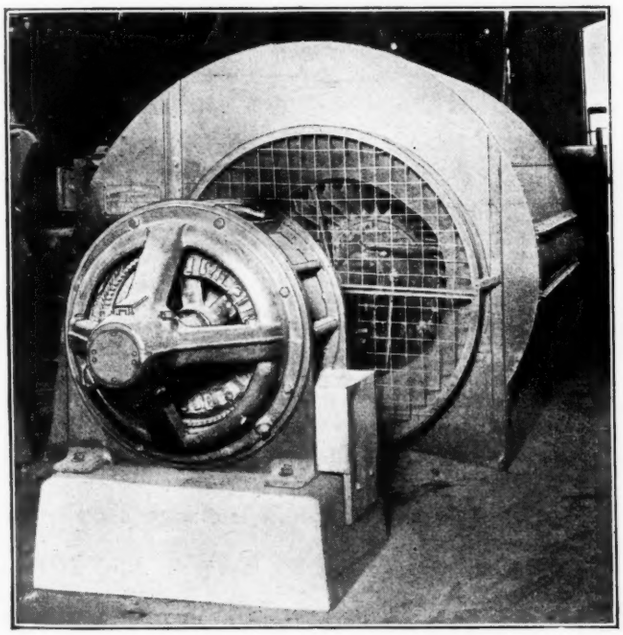


FIG. 3. PLATE-TYPE CENTRIFUGAL FAN

Reduction of outlet of a rotary blower increases the pressure and increases the load accordingly. A fully restricted outlet might burn out the motor or damage the blowers if no protection were provided. If the inlet were fully restricted, the pressure difference would approach atmospheric pressure. As this is more than the usual pressure for this type of blower, an overload condition would result.

It will be seen from the foregoing that any type of fan or blower may overload its motor if the speed exceeds normal value. A centrifugal fan motor may be overloaded if the discharge openings are increased above normal. Propeller fans may be overloaded by restricted discharge. Rotary blowers may be overloaded by restricted discharge or restricted inlet. Particularly in the case of rotary blowers, the actual conditions determine the load, rather than the name-plate on the blower, as a given equipment may be used under different conditions and cause widely different loads. In view of these facts it is evidently desirable to equip controllers for motors driving fans and blowers with overload protecting devices of some kind.

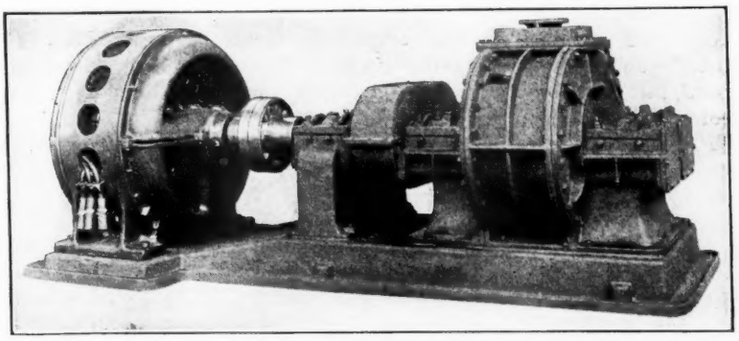


FIG. 4. POSITIVE-PRESSURE ROTARY BLOWER WITH DIRECT-CONNECTED MOTOR DRIVE

Many centrifugal fans operate normally at constant speed and output. For such drives shunt-wound direct-current motors or squirrel-cage induction motors are commonly used, according to the nature of the electric service available.

Inasmuch as the power required by a fan varies rapidly with a change of speed, it is important that care be taken to see that the rated fan speed is closely met. The actual full-load speed of shunt-wound motors is likely to vary 3 to 5 per cent from the rated speed, owing to manufacturing variations. The hot speed will usually run 3 to 5 per cent higher than the cold speed. A resulting variation of 6 per cent from rating would alter the fan pressure about 12 per cent and the motor load about 19 per cent. The need for accuracy in speed is thus evident.

It is good practice to use compound-wound motors for fans, particularly when the voltage may vary or when different blast pressures are required. The drooping speed characteristic tends to maintain the motor load more uniform under changes in voltage and system pressure. In like manner unless wound-rotor motors have sufficient permanent resistance to give drooping speed regulation, changes in system pressure are likely to cause wide load variation.

Where variation in volume or pressure is desired, speed adjustment is desirable. In the case of induction-motor drive, it is common practice to operate the fan at constant speed and manipulate dampers to control the volume or pressure. With direct current available, speed adjustment is commonly provided. This may take one of three forms—regulation by armature resistance, field control or combination control.

Armature control is obtainable at least first cost but is relatively inefficient in operation. The losses are not proportional to the speed reduction, but increase more slowly to the least efficient point, which occurs at about 60 per cent speed. As the load falls off with decrease in speed, the losses do not ordinarily exceed 20 per cent of the motor input.

Field control involves high first cost, but is economical in operation. It should be borne in mind, however, that

the greatest load does not occur at full field condition, so that a closely rated motor should be selected.

Combination control employs 10 to 25 per cent speed adjustment by field control and about 50 per cent speed regulation below normal by armature control.

Where the motor operates for long intervals at speeds between 50 per cent and 100 per cent of maximum, field control will show sufficient economy to justify its first cost. If the motor operates for long intervals at speeds ranging from 75 to 100 per cent of normal and occasionally at lower speeds, combination control is best suited. For motors operating normally at or near full speed, but occasionally at reduced speeds, armature control is satisfactory.

Propeller-type fans commonly operate at constant speed. The squirrel-cage induction motor is employed usually as an alternating-current drive. With direct-current, shunt-wound motors are used mostly on the larger units and series motors are applied frequently to the smaller fans. They protect themselves automatically against overload by slowing down under load increase. Small series motors driving fans can be started by connecting directly across the line. The series motors develop high starting torque per ampere input and the starting load is small.

Rotary blowers are driven, usually, by squirrel-cage induction motors or by shunt-wound direct-current motors operating at constant speed.

For all types of fans and blowers the starting torque is relatively low, comprising friction and inertia loads only. If a centrifugal fan starts with the discharge closed, the load during acceleration is less than if the discharge be open.

Small Fans Suited to High Speeds and Direct Drive

Small fans are adaptable to fairly high speeds and are well suited for direct drive. Very small fans only should be mounted on the motor-shaft extension. Two bearing fans, with a flexible coupling, are used commonly because of lower cost and to avoid having a bearing in the air or gas flue or duct. With this arrangement solid construction is desirable, to preserve alignment.

Larger centrifugal fans run normally at lower speeds. Motors suitable for direct connection are therefore high in cost. Where sufficient space is available, belt drive can be used to advantage, as it permits the use of higher-speed motors.

Besides, belt drive has advantage in other respects. Where a centrifugal fan is to exhaust into a system of ducts, the delivery of the fan and its consequent load may be difficult to determine in advance with sufficient accuracy to permit direct connection with no means of speed adjustment. For such a condition belt drive offers the advantage that an adjustment may be made readily by the simple expedient of a small change in pulley diameters, thus correcting any error in predetermining conditions. Belt drive has the further advantage in that it prevents noise from the motor being transmitted to the fan and carried into the ducts. In office buildings and elsewhere such noise is objectionable. The preceding applies particularly where induction motors are used, as they tend to be more noisy than direct-current motors.

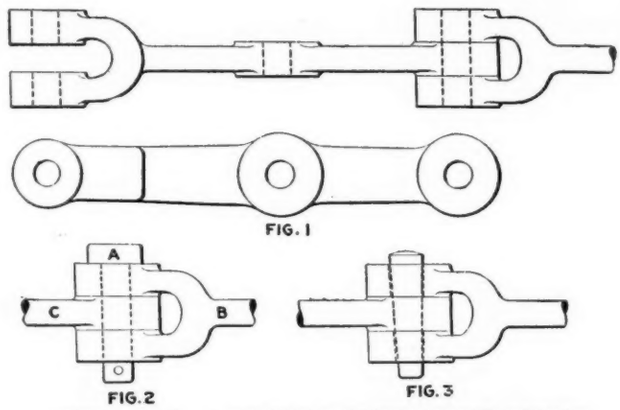
A positive-pressure rotary blower is normally a slow-speed machine. The speeds range from 1,000 r.p.m. in small sizes to 100 r.p.m. in large sizes. The motors may be direct-coupled or may drive through a belt or gear. The direct-coupled or belted drives are to be preferred. If gearing is used, the motor should be mounted on an extension of the blower bedplate in a manner to afford a substantial self-contained unit.

Synchronous motors are used sometimes for driving large, continuously operated fans. A self-starting synchronous motor suitable for this purpose will have a low-resistance squirrel-cage winding, giving low torque at standstill, but bringing the motor well up to speed and minimizing the pull-in torque required when the motor is nearly up to speed and well loaded.

Very large fans which require adjustable-speed drive, such as mine fans, are equipped frequently with wound-rotor motors and have an auxiliary motor-generator set to give dynamic speed adjustment. Polyphase commutator motors also are used for this service. These drives are designed for reduced horsepower at reduced speed.

Taper Pins as Labor Savers

A case where a resourceful man made his head save his heels was described in a recent article by E. A. Dixie in the *American Machinist*. He had a job of overhauling an old upright gas engine out in the country where there was no machine shop and very little in the way of tools of any kind. The part that needed repairs most was the spark mechanism, consisting of a number of links and yokes, such as are shown in



FIGS. 1 TO 3. A SIMPLE BUT EFFECTIVE REPAIR
Fig. 1—The worn links and yokes. Fig. 2—The original construction. Fig. 3—As repaired by the taper pins.

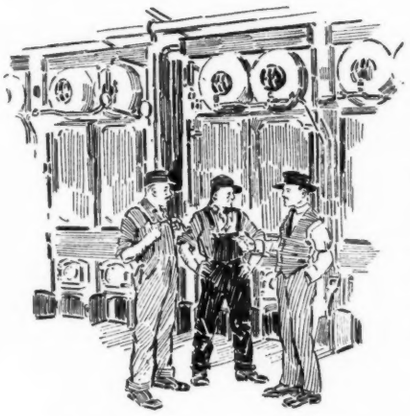
Fig. 1. The holes in these pieces had worn badly oversize and out of round.

The original construction is shown in Fig. 2; the pin *A* was made a sliding fit in both the yoke *B* and the link *C* and was held in place by a cotter. Mr. Dixie, however, did not follow the maker's design, as many mechanics would have done, for that would have meant hunting around for an odd-size reamer and then making special pins to suit. He found there was a set of taper reamers on hand, and so, setting the parts in position, he taper reamed the holes until they were round. Then he separated the parts and reamed the yoke hole a little larger, so that when the pin was in position it would be tight in the link and would have a running fit in the yoke. This was better than to have made it tight in the yoke and running in the link, because it gave the greater amount of bearing surface. In a case of this kind the yokes must, of course, be reamed out large enough to permit of driving the pin home very tight, so as to eliminate the possibility of its working loose. Fig. 3 shows the job as completed.

Railroad Stationary Engineering

By A. D. PALMER

I NOTICE in looking over the daily papers that there is a considerable amount of discussion relative to a proposal by the railroad heads to abrogate the so-called National Agreement, under which railroad employees have been working. If the public understood this agreement, it would not be necessary for the railroad heads to take any steps in the matter of abrogating the agreement, as there would be such an outcry that the Government would be forced to step in and end it once and for all. In plain words the National Agreement handed the railroads over to the men and their organization. In itself there would be nothing objectionable in this, provided the men had been competent to handle the roads, but they were not. Neither were they in any way interested in the service rendered to the public or in the dividends paid to those who have invested money in the properties.



"A COMMITTEE VISITED ME"

During the year 1919 I was persuaded against my own good judgment to take a position as chief engineer in a large local railroad repair shop. Conditions in this plant were abnormally bad, owing to poor supervision, lack of interest in the plant on the part of the help, and a general "I don't care" feeling on the part of those higher up. The service was intermittent, cost was high for both operation and maintenance, and the total efficiency of the plant was not worth studying out.

Based on the fact that my superior promised me his staunch support, I tackled the job. I early found out that only up to the point where I bucked the committees would I get the promised support. It did not matter whether I was right or wrong, the committee got the benefit of the doubt in all cases.

To cite a little incident showing just how the agreement works, in taking charge of the plant I found the boilers in a general dirty condition. Settings were in bad shape, baffles were destroyed, and the stokers under most of the boilers were in such condition that much of the coal passed directly to the ashpits. These conditions I started to remedy with the services of my own help.

The Federal rules require that boilers be inspected internally once a month and that they be inspected by the supervising officer in charge of the boilers. This was my position. At the time of this inspection the boilers are to be washed and a certificate is signed by the chief engineer stating what was done, etc. This being the Federal law, it was the policy I followed.

There were six boilers in the plant, and under normal conditions I could arrange to cut out two boilers on a Sunday for cleaning. This means that on three Sundays in the month I used two of my men to wash boilers—seven-day men working on my payroll, therefore there was no charge for labor. On the last Sunday I allowed these men an easy day, hence everybody was satisfied with the conditions. There was no labor charge and gaskets and water charge amounted to about $1.25. In general the boilers were ready for service at about 1 p.m. After I had performed this work for about three months, I was visited by a committee, who informed me that this boiler washing was their work, basing their claim, when I asked to see the agreement giving them boiler washing as boiler work, upon the statement in the National Agreement, "all work recognized as boilermakers' work." Personally, I failed to see where boiler washing was or is boilermaker's work, my conclusion being that it is laborer's work. I failed to find anything in the agreement giving this work to this craft, but in fighting it I was overruled and boilermakers were allowed the work.

The following Sunday (this being overtime work) I had two boilers to be washed. I notified the boiler-shop foreman of my requirements, and two boilermakers with two helpers were sent to my plant. I arrived about 9 a.m. and up to this time, although the men had been on the job since 7 o'clock, nothing had been attempted by the four men assigned to this work. I assumed that they awaited my instructions, but was informed upon approaching them that they "would take no orders from a grease-slinging engineer." After some discussion in the presence of one of their own supervisors, they began work, and feeling thoroughly disgusted with the whole affair I returned to my office, leaving a man to watch proceedings and to report to me if necessary. In about an hour this man came to my office and asked if it was my intention to operate the boilers being washed the next day. I replied that it was.

"WOULD TAKE NO ORDERS FROM A GREASE SLINGING ENGINEER"

"Well, Chief," said he, "if you want those boilers tomorrow, you had better come down to the boiler room and see what those fellows that call themselves boilermakers are up to."

I visited the boiler room and found the boilermakers washing the asbestos covering from the heads and the soot off the outside of the tubes. No manhole or handhole plates had been removed. I had the water shut off and asked them if that was the method they employed in the shops, and they replied that they never did that work in the shops, that sort of work generally being assigned to helpers and laborers. The man in charge

of the crew said that he had never seen a boiler of this type in his life before, and out of the four men only one of the helpers had ever performed work on such a boiler and this was to assist in replacing a tube.

This little job cost $20.10 per boiler, as these men made the job last ten hours, declining to do the work unless they could have that time. Boilermakers got $1.08 and helpers 93 cents an hour. On the following week the boilermakers assigned to this same work asked for and secured an extra helper, stating that three helpers were needed for two boilers. This was very much against my wishes. In cases where I had one boiler to be washed, it was necessary to pay one boilermaker and two helpers ten hours' pay for work that is done all over the country in industrial plants by two men, and often only one man in two hours. I took this matter up with my superintendent, but was forced to accept this condition throughout my service.

My second experience with the National Agreement was as follows: My coal conveyor operator reported that a part of the monorail track was in a dangerous condition, and after inspecting it I agreed with him. This consists of a single track, upon which a conveyor runs carrying coal from the cars to the stoker hoppers. It passes directly over the firing aisle, in which men are working, and any defect in the track is a danger to the firemen. I decided to have a welder cut out the defective part of the track, about four feet in length, and to install a new piece. I sent for a welder, but upon seeing the job he declined to look it over until a staging was rigged up. In the general run of mills two ladders would have been considered ample for the job, and there would have been no danger to the operators. After the staging was arranged I again sent for my welder, and when he had looked over the job he informed me that as he was a boilermaker's welder, he could not cut off the two bolts that supported the track, hence it would be necessary to have a machinist's welder for this work. In all this visiting the job, Mr. Welder had his helper in attendance. In this particular case it meant two high-paid welders and two helpers to perform a job calling for one man for about two hours. The total time consumed was eight hours per man.

"THEY WERE WASHING THE ASBESTOS COVERING FROM THE DRUMS"

Under the National Agreement if a man works 40 minutes overtime he is allowed one hour's pay. If the job is not then finished, he must be given time to secure a meal, and if the job is not finished he will come back to work, and assuming that there is only five minutes' work on the job, he will receive pay for five hours and twenty minutes.

I had a case of this sort, and will describe it, as it illustrates just how the trick works out. A stoker engine broke down at 2:30 p.m. A light load allowed us to drop the boiler served by the stoker engine. A machinist and helper started work at once. The plant shut down at 3 p.m. and the men worked until 3:10 p.m and then quit for lunch, although there was only about ten minutes' more work to do. They returned at 4:10 finished the job at 4:25, and then washed up and got their train. Seven hours' pay for fifty minutes' work. This is based on the National Agreement. in which it is stated that employees required to return to work after regular hours will be allowed 5 hours pay for 3 hours and 20 minutes or less. Let us assume that another engine broke down while these men were washing up. I am forbidden to retain them, but must send out for a new machinist and his helper. In other words they are only allowed to do that work to which they were assigned in the beginning of the job. Under the National Agreement no supervising officer has any authority to employ a man. The job vacancy is posted for a period of five days, and any man having the rating and the seniority, irrespective of his fitness for the position, has the right to the job.

"IT WASN'T HIS KIND OF A WELDING JOB"

A man who has been in the service of the road for a period of 30 days cannot be discharged for incompetence, and assuming that you desire his removal, it calls for an investigation, with the odds all in the man's favor. As a general thing if a man is discharged he lets the case hang, while he takes a few months' vacation, and then after the investigation he will receive his three months' back pay for no service rendered.

I have been unable to find in the National Agreement any data covering the matter of supervision. According to the committees each craft shall be supervised by their own foreman. Yet on no job performed in overtime hours did a foreman ever to my knowledge come into my plant and boss the same. The men declined to take my orders, and therefore on important work there was no supervision, time was wasted, cutting down our production, and in many cases the job was only half done.

I have a case in mind that well illustrates this point. At about 2 a.m. I was called up on the phone by my night engineer, who informed me that a tube in the middle bank of No. 2 boiler had failed. As No. 1 boiler was down for repairs, we needed this boiler badly. I ordered my engineer to have his fires dumped, to reduce his pressure, and as soon as the pressure was down to 10 lb. to blow the boiler down. This was done.

At 7 a.m. I notified the boiler-shop foreman of the work on hand, and at 8:30 a.m. two boilermakers and two helpers reported for work, and at once set up a howl for a staging. This called for four riggers. Work

started on the boiler at 2 p.m., and the boiler was not returned to service until two and a half days later.

Against the foregoing, consider the following little story relative to the method of handling a job of this sort in a plant where supervision is supplied. In this particular plant (a street railroad power station) we required, at the peak load, from 5 to 7 p.m., our full boiler capacity. One night six tubes failed in No. 1 boiler at about 3 a.m. The engineer called me up and received orders to dump the fires and empty the boilers as soon as the pressure dropped to zero. At 6:30 a.m. I secured, on my way to the plant, an Italian laborer, whose position in our plant was that of boiler repair man, and two common laborers, men who under normal conditions worked in the coal yard. The boiler was opened and work started at 7:15 a.m. without a staging. The boiler was in service with 200 lb. pressure at 4 p.m. The cost for labor was $11.04 with no loss due to reduction of service. Some difference!

"LETS THE CASE HANG AND TAKES A VACATION"

Oil Engine for Peak Loads

BY E. C. FAWCETT

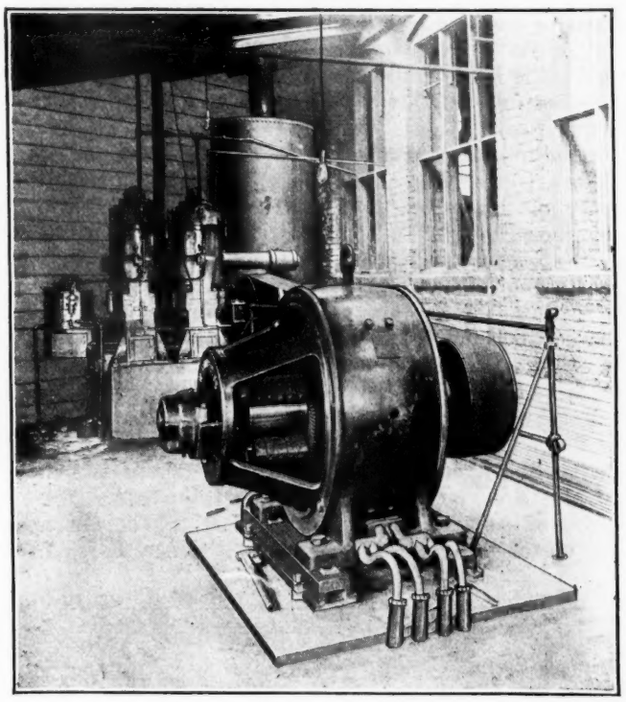
During seasons of extreme activity many manufacturing plants find their power equipment insufficient for the peak-load demands. Increase in the power plant then becomes necessary, and in many instances it is almost impossible to find space in which to place new boilers and engines. The G. W. Pyott Co., of Chicago, was confronted with this problem last year. The power plant, which supplied the foundry, machine shop and pattern shop, consisted of two horizontal-tubular boilers and a 100-hp. Corliss engine. The space available for additional equipment was very small, and it was necessary to purchase electric current or to install an oil engine.

An 80-hp. Ven. Severin semi-Diesel oil engine was installed and belted to a 75-kw. 115-volt direct-current generator with 15-ft. belt centers. The unit is shown in the illustration, the floor space occupied being 15 x 30 ft. This unit has enabled the factory to run at maximum capacity and has shown a surprising economy when compared to the steam-plant costs. In overload capacity it of course fails to compare with the Corliss, but nevertheless it has carried 96.2 electrical horsepower for a three-hour period.

The cost of oil-engine operation, including water, oil, part of engineer's time, etc., averages $9.49 a day. The present plant cost of both the steam and oil engine is $33.24 a day, while formerly the steam plant alone, although delivering less power than the present plant, cost $42.32 a day. This includes labor, coal, oil, waste, etc.

Beyond this saving there is another advantage in using oil engines for peak-load service. Often the shop has a rush job requiring overtime labor. With the steam plant it was necessary to keep the fireman and engineer at the plant and the coal cost was about the same as when running at full load. This made a job expensive. The oil engine enables the shop to operate overtime without the engineer or fireman staying. The mechanics can stop the engine when leaving; this permits work done at overtime rates to be billed at substantially lower prices than heretofore.

The fuel-oil and lubricating-oil consumptions are surprisingly low for a semi-Diesel engine. On an observed run the results tabulated were secured. In view of the unloaded condition of the unit the fuel consumption is most commendable.



OIL ENGINE FOR PEAK LOADS

Time	Gal. Fuel	Lub. Oil, Pints	Kilowatts	Kw. per Gal. Fuel Oil	Kw. per Gal. Lub. Oil
7:30 to 8:30 a.m.	4.629	1	34.50	7.45	276
9:30	4.629	1	34.00	7.45	270
10:30	4.166	1	34.25	8.22	274
11:30	3.240	1	28.75	8.87	250
12:00	2.314	1	20.00	8.69	160
12:30 to 1:30 p.m.	4.166	1	34.70	8.33	278
2:30	4.166	1	34.56	8.30	276
3:30	4.150	1	34.00	8.17	272
4:40	4.029	1	40.00	8.88	320

A Correction

In the April 5 issue, beginning on page 548, is an article, "Considerations in Motor Applications," by Philip Chapin Jones, Electrical Engineer, B. F. Goodrich Tire and Rubber Company of California. Unfortunately, a mistake, which *Power* regrets very much, was made in the name of the company that Mr. Jones is connected with. It should have been Goodyear Tire and Rubber Company of California.

The primary horsepower in Porto Rico increased 97.7 per cent in the ten years from 1909 to 1919 from 34,005 to 67,226.

United Traveling-Grate Stoker

The accompanying illustrations show the design and construction of a new traveling-grate stoker which is made by the United Stokers Co., of Hammond, Ind. It has a flexible double drive, giving practically uniform motion to the grate, longitudinal tracks to support the upper and lower runs, counterweighted dampers to shut off the rear portion of the grate area, a special feed gate and ignition arch and the usual provision for air sealing.

The cast-iron side frames are heavily ribbed and are made in sections bolted together to eliminate warping and to facilitate handling during shipment and erection. The head-frame castings are outside of the furnace setting and air-cooled liners protect them from hopper fires.

Structural-steel cross-girders, Fig. 1, spaced on 3-ft. centers, connect the side frames; they also support the upper and lower longitudinal drive chain tracks, which are spaced from 15 to 21 in. on centers across the width of the stoker and are bolted to each girder. The longitudinal tracks eliminate chain sag and provide a flat foundation for the fuel bed. There is in addition diagonal bracing to maintain the proper alignment of the stoker frame. Above the longitudinal tracks are the drive chains and on top of these the grate sections. Consequently, the drive chains are considerably below the fire and are not subjected to furnace heat. Each driving link is supported by two track rollers on which the pins are riveted over to prevent the rollers from coming off. Owing to the construction outlined, the sole function of the grate is to support the fuel bed. The

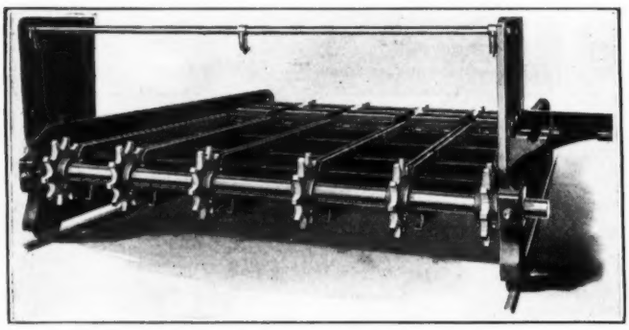
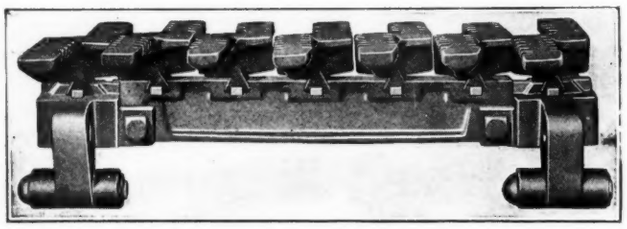


FIG. 1. INTERNAL CONSTRUCTION OF STOKER

grate sections are not subject to driving stresses and are free to expand or contract under operating conditions without causing friction in the machine.

As shown in Fig. 2, the grate is made up in unit sections consisting of the grate bar, the drive links on either side which form a continuous chain, and the individual grate sections supporting the fuel bed. The offset construction of the grate section was adopted to simplify the method of support and to produce a definite shearing action for cleaning the air space when the grate surface passes around the sprockets, front and back. At these points there is considerable space between grate sections so that the keys holding them in place can be reached and also the pin through the drive links and the bolts securing the grate bars to the drive links. To prevent the sifting of coal through the grate, the air openings have been made at an angle from the vertical, so that to pass through, the coal must slide over a rough surface instead of dropping through an opening.

On the bottom of the grate section are dovetailed lugs which fit into corresponding recesses on the grate bars and drive links. Both the lugs and recesses are tapered so that the lugs can be inserted from but one side and cannot slide beyond a predetermined point, thus bringing all the sections into proper alignment. Steel keys are placed under the lugs and locked to pre-



FIFG. 2. UNIT SECTION CONSISTING OF GRATE BAR, DRIVE LINKS AND GRATE SECTIONS

vent the grates from backing out in the direction from which they were inserted. Each key holds but one grate section, and all keys may be reached easily as the grate surface passes around the front sprockets.

To replace a defective grate, the key holding it is cut off with a chisel and the section removed. A new key is then inserted, with the lug of a new grate section, into a recess.

The drive shaft is mounted in cast-iron bearing boxes carried in the headframes with arrangement for front

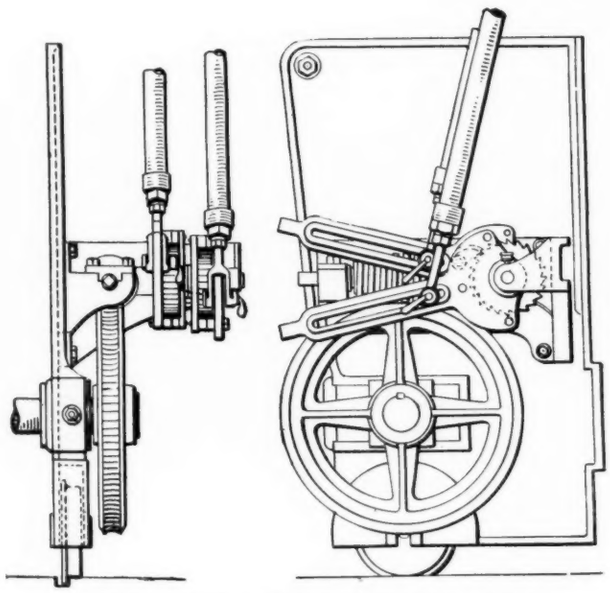


FIG. 3. DOUBLE-RATCHET STOKER DRIVE

take-up adjustment. On the rear or idler shaft the sprockets are held in place by collars and are free to turn on the shaft and adjust themselves for any difference in length of the drive chain due to uneven wear.

The stoker drive, shown in Fig. 3, consists of a worm and wheel actuated by a double set of ratchets driven by eccentrics set 180 deg. apart on the lineshaft, the location of the latter being overhead or in the basement, as desired. The double ratchet drive produces a nearly

constant chain movement. Each drive arm carries a double pawl, making a close adjustment of connecting rods unnecessary to secure easy running. Regulation of the grate speed is obtained by varying the position of the connecting rods in the slots of the drive arms. The adjustment provides for grate speeds of from 0 to 9 in. per minute, higher speeds being secured by increasing the rotation of the lineshaft.

At the rear of the stoker dampers are provided to shut off portions of the grate area when this is desirable. These dampers are counterweighted and are operated from the front of the stoker by levers. The whole mechanism is an integral part of the stoker.

Fig. 4 shows a section of the feed gate, which is raised and lowered by a worm-and-wheel mechanism, the amount of opening, ranging from 0 to 12 in., being indicated by graduations on the wormwheel. The gate frame is suspended from the operating shaft by chains. Tapered supports keyed to the frame suspend individually the feed-gate tile. These supports may burn off piece by piece, but the remaining tapering section holds the tile in place.

Waterbacks of either the high- or low-pressure single-pipe type are provided. In the flat ignition arch employed, the tile are hung from cast-iron supports suspended from I-beams resting on the furnace side walls. Each row of tile is supported independently of all others, and renewable arch tips make possible the repair of the arch at the point of the greatest wear without disturbing the remainder.

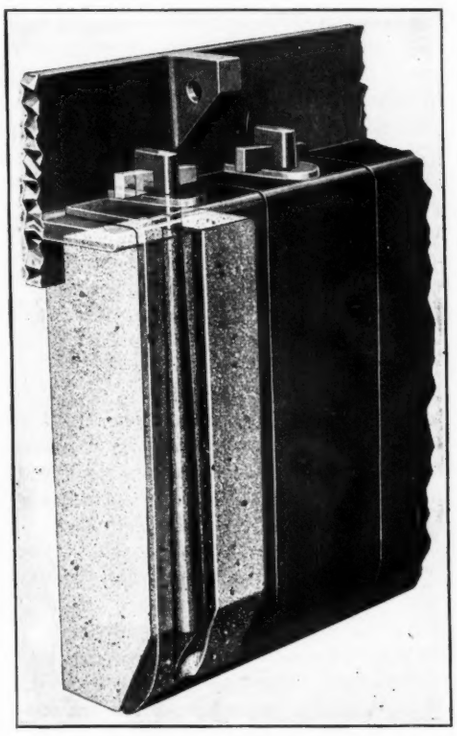
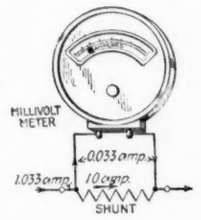


FIG. 4. TYPICAL SECTION OF THE FEED GATE

There are many reasons for flywheel explosions, but a large number of them can be attributed to ignorance and carelessness and the operation of engines with worn-out and unreliable governors.

Errors in Low-Capacity Shunts

In the ordinary direct-current standardizing ammeter sets there will often be found low-current shunts of from one up to several hundred amperes These shunts are accurately adjusted to give a certain drop—for instance, 50 or 100 millivolts at their rated capacity on a potentiometer—and are generally used interchangeably with the same millivoltmeter. There is, however, a serious error when using a millivoltmeter with a low-current shunt.



ILLUSTRATING ERROR IN LOW-CAPACITY SHUNTS

Assume that the millivoltmeter has a resistance of three ohms and reads full scale on 100 millivolts.

From Ohms Law, $I = \frac{E}{R}$; or $\frac{0.100}{3} = 0.033$ ampere.

The meter requires 0.033 ampere to make it read full scale. Likewise the resistance of a 1-ampere 100-millivolt shunt is $R = \frac{E}{I}$, or $\frac{0.100}{1} = 0.1$ ohm. Connecting the meter to the shunt as in the diagram, there must be 1 ampere in the shunt to give a drop of 100 millivolts, and 0.033 ampere through the meter to make it read full scale. Therefore, the line current is not one ampere, as the full-scale reading indicates, but 1 + 0.033, or 1.033 ampere. This particular combination, therefore, gives an error of 3.3 per cent.

Another way of looking at this is to consider that 3 ohms (instrument resistance) in parallel with 0.1 ohm (shunt resistance) gives a total of $4\ \frac{1}{\frac{1}{0.1} + \frac{1}{3}}$, or 0.0967 ohm. Passing a line current of 1 ampere through this combination would give only 1 amp. $\times$ 0.0967 ohm = 0.0967 volts, or 96.7 millivolts, whereas the instrument requires a drop of 100 millivolts.

A 5-ampere shunt with the same meter will give an error of $\frac{1}{5}$ that of a 1-ampere shunt or 0.65 per cent, and with a 10-ampere shunt the error would be 0.33 per cent. Thus it will be seen that even for commercial accuracy, the error of using a millivolt meter and shunt below 10 amperes must be calculated and readings compensated accordingly.

Many firms adopt the practice of adjusting the shunt to suit the meter with which it is used. Thus in the preceding case, the 1-ampere shunt would be adjusted to give 100 millivolts on 0.967 ampere, and the 5-ampere shunt on 4.967 amperes.

The generation of steam by electricity has not yet reached the commercial stage in this country, although in Switzerland, France and Italy a number of such installations are in successful and economical operation. Two of these have already been described in *Power*, and an early issue will contain an illustrated article giving an account of one in Sweden in which units of 2,000 kw. each furnish steam at 170 lb. pressure.

Weight for weight, wood has a low calorific value as compared with coal, from two to three tons of wood having to be used to give off the same amount of heat as that obtained from one ton of average coal.

Adjusting a Machinist's Level

By Eustis H. Thompson

High-speed machinery is often built with provision for leveling in order to maintain the alignment when being installed. As levels for such purposes are necessarily of sensitive construction and much more easily put out of adjustment than the ordinary kind, means are usually provided for readjustment. The ordinary test in such a case is to place the level on a plane surface so that the bubble is approximately central, noting its position with accuracy. The level is then reversed, end for end, and if it is in proper adjustment, the deflection in the bubble will now be the same as before noted. This process is not very satisfactory, and if after several trials, there remains some doubt as to correctness, such levels are often placed in the hands of the manufacturer or some instrument-repairing concern with the idea of obtaining the greatest accuracy of adjustment, which is unnecessary if the proper method is followed with a little care and patience.

When it is desired to adjust a level accurately, it is necessary to find a plane surface such as a scraped surface plate on which the level can be placed. Sensitive levels are very likely to show a different deflection every time they are picked up and put down in the same place. This is due to a small amount of dirt or foreign matter

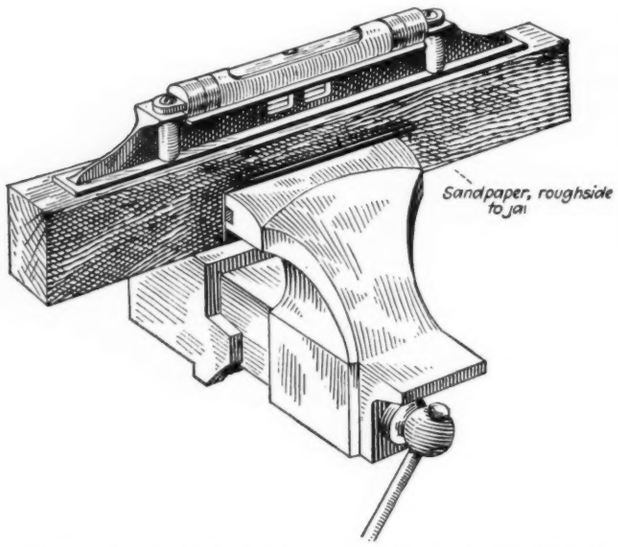


FIG. 1. ADJUSTMENT BY PARALLEL BLOCK IN VISE

on the level or surface plate or to very slight irregularities of the surface plate or level. The first operation is to put the level and plate into such condition that the level may be lifted and replaced several times without varying the reading of the bubble. It will be necessary to clean with gasoline or similar solvent and a clean rag, and if a high spot or other irregularity of surface exists, either scrape the surface or find another suitable one. It is most convenient to mark the position of the level on the plane surface with chalk or pencil, so that it can be easily returned to the correct position each time. It should also be remembered that the spirit phial may possibly be loose in its fastenings and thus cause different deflections.

The next step is to mount the plane surface in an approximately level position so that it can conveniently be tilted or inclined a very slight amount, and then maintained in position. A parallel block can be placed in a vise, as shown in Fig. 1, and tilted by tapping lightly to suit conditions. A regular "surface plate" or "plane surface" can be set on a planer or other solid support and inclined by using thin wedges at one end as shown in Fig. 2, with a lever block for convenience.

Place the level on the plane surface and mark its position so that it can be replaced with exactness. Now

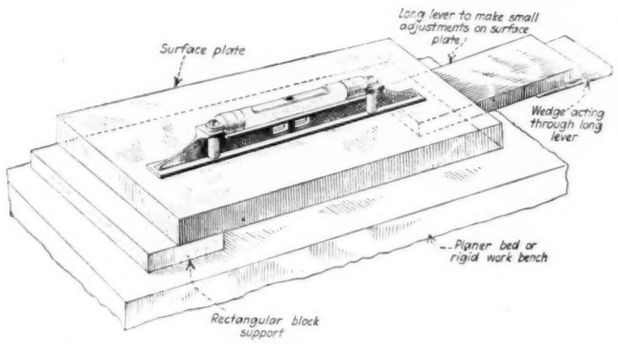

Long lever to make small adjustments on surface plate
Surface plate
Wedge acting through long lever
Planer bed or rigid work bench
Rectangular block support

FIG. 2 SURFACE-PLATE METHOD OF ADJUSTMENT

tilt the surface until the bubble is located in the exact center of the phial, or glass container and lock the surface in this position. Next lift the level up, reverse it end for end and replace. The deflection of the bubble will show twice the actual error. The phial should now be adjusted so that the deflection is half as much. This will be approximately the correct setting. Tilt the plane surface until the bubble stands in the exact middle. Reverse the level and note if any deflection is apparent. If not, the adjustment is more accurate than can be judged by the eye in reading deflections. If, however, there is still deflection visible, the process should be repeated until there is no change apparent in the level. The adjustment screws for setting the phial should be locked and the accuracy again checked. If there is a sliding or revolving cover to the phial, this should be operated and the level again checked to see that this does not disturb the adjustment.

This method takes advantage of the ability of the eye to pick out the central position of the bubble with much greater accuracy than is possible in reading the deflection of the bubble. The deflection that takes place when the level is reversed is approximately twice the actual error of inclination of the plate, and therefore the degree of adjustment is more accurate than the limit of error when reading a deflection.

In case it is desired to repair a level by inserting a new phial, it is not a difficult matter to do so with plaster of paris and then adjust as before described. It is important that white material such as clean plaster of paris or good white paper is placed next to the phial in order to provide reflected light for reading the bubble. Make sure that there are no kinks or springs or other strains in the mechanism that contains the phial.

The sensitiveness of a level may be demonstrated by trying to hold the bubble in the middle position by hand. This is not difficult with ordinary levels, but sensitive instruments will be thrown out of true by the vibration of the body.

The most sensitive phials are of ground glass, while ordinary ones are made of blown glass. The bubble is much larger in cold weather than in warm, and accuracy is much increased with a large bubble as found in cold temperatures.

EDITORIALS

Controlling the Steam Supply

MR. BUTLER'S article in this issue, entitled "Load Dispatching in a Central Heating System," might well have had as a subtitle, "A Tribute to the Steam Meter."

Flow meters for steam mains are no new thing, as engineering literature for the last twenty years or more bears witness, but the early Andrews, St. John and Sargent types were used mainly for the actual measurement of steam, sold as such to a customer, while it is only within the last ten years or so that the "flow meter" has come into its own as a boiler-room and engineer's office instrument and adjunct for the intelligent control of steam generation and distribution.

"Street steam" on a large scale is one of the most expensive forms of public service, in the relation of maintenance and upkeep expense to income, and not the least of the trying problems for the engineering and operating departments has been the necessity for providing and continuously maintaining a reserve supply sufficient to cover the fluctuating demands of large consumers. The ability to control and even reverse the flow of steam in various parts of the system, with reference to separately generating, tied-in units, makes for a flexibility and consequent economy only recently attainable.

Future possibilities in multiple-unit steam plants for public service based on an elaboration of the block-plant idea, are great, and developments will be watched with interest.

Heat, Energy and Civilization

CIVILIZATION dawned when man mastered fire. With fire as his servant the resources of the earth became available. The extent of social and industrial progress may be measured by the utilization of energy. Today, the social and industrial fabric of the great powers depends upon energy. In the home, the shop, the factory, are countless demands for energy, as well as for transportation on land and the seven seas. Heat, power and light have become necessities. Heat energy in these three forms goes toward the production and fabrication of all materials, their distribution and utilization, and contributes to comfort and pleasure. It is less than two centuries since the Darbys revived the art of smelting iron with pit coal, which had fallen into disuse after the death of Dud Dudley, its originator. In less than two hundred years industrial progress has surpassed the attainments of all the countless ages preceding. The last fifty years has surpassed the whole hundred and fifty preceding it. The veil of the future is yet to be lifted.

Natural energy resources are the most valuable assets of the world. Iron stands second. But the potential sources of heat are pre-eminent over all. Energy utilization in economic service comprises transportation and transformation. The natural heat-energy resources are only potential until they have been won from the earth and delivered where they can be transformed into heat, power or light and utilized. Every step of their progress takes its toll of energy. The locale where the energy demand exists, is rarely the locale where potential energy is stored. These two regions must be linked by transportation. The first canal in England and the first railroad were built to carry coal. Today over a third of the freight hauled by rail is coal. Its retail delivery by truck is no small portion of city traffic.

Transportation is the weak link in the energy problem, particularly in congested industrial regions. Heat, power and light demands of home and industry must be met by a continuous supply. These demands are complex and are difficult to link up to one form of energy supply. The superpower plant may be able to meet some of the energy demands of power, heat, light and certain forms of transport. The super-gas plant may meet some of the demands of heat and power. Motor transport requires a vaporizable fluid energy. Certain metallurgical processes require coke. The problem of the congested region is not the supply of one form of energy alone, but the super-energy transformation plant and the delivery of that energy; this last is no mean problem.

Maintenance and Emergency Repairs

POWER equipments of any kind, be they mechanical or electrical, are like human beings—to get the best out of them they require care. And it has come to be generally recognized that the cost of maintaining both in good condition is usually a good investment. Maintenance of power equipment has many features to recommend it, such as continuity of service which results in increased production, decreased cost of maintenance and replacement, safety, and increased life of the equipment.

Continuity of service is now looked upon as an essential feature of the small plant as well as of the large installation, since it is not so much the cost of repairs as the loss of production due to the machinery being shut down that makes interruptions to service costly. Equipment that is regularly inspected and repairs made when necessary in the main costs less to keep in service than that which is looked after only when it fails to function properly. Careful inspection may detect defects that, if not remedied in time, would have resulted in wrecking the machine or in expensive repairs. The replacement of a bearing in a motor is of minor consequence, yet if a worn bearing is not detected and replaced it may result in the burning out of the machine. Or if the load that the motor is driving is not checked periodically, conditions may develop that will result in complete burnout if the equipment is not properly protected against overload.

In general, a machine that is not properly maintained may be considered dangerous to life and property. This statement is only too forcefully substantiated by boiler explosions, engine, turbine and electrical-machinery wrecks, falling elevators, fires and property loss due to

improperly maintained electrical equipment, etc. Although all failures are not due to lack of proper maintenance, nevertheless a large percentage of them are. Accidents do happen when the most careful inspection and maintenance methods are practiced, but the number that occur under those conditions is small compared with those that happen where negligence exists.

Along with proper maintenance, consideration must be given to emergency conditions, which may arise in the best cared for plants. It is true that what to do in making emergency repairs depends largely upon the ingenuity of the man on the job, and in many cases is dictated by conditions arising that cannot be foreseen; nevertheless, a little study of the plant will lay a good foundation for quick work. For example, if an important motor burned out, is there one in some other part of the plant that could be spared to take its place until repairs are made, or if this cannot be done is the cost of a spare motor or spare parts justified? If an important feeder failed, what would be the quickest way to install an emergency circuit until the original could be replaced? Similar questions can be applied to every part of the power equipment. Not infrequently a careful study of the equipment will reveal weakness in the layout that can be prepared for in advance by even a small investment, and prevent serious interruptions to operation.

Influence of Use Factor on Engine Design

IN DESIGNING power plants for industrial service the importance of the use factor is often ignored. It is hardly profitable to install a highly efficient and costly power plant if the use is to be confined to a short period of the year. Possibly a cheap, inefficient plant would in most cases prove the economical one when the interest and other carrying charges are taken into account. On the other hand, if the use factor is fairly high, the increased overhead is more than offset by the decreased operating costs.

In the foregoing lies the explanation why the small-power Diesel engine has been developed notwithstanding the lower manufacturing costs of the surface-ignition and other oil engines. Even though the Diesel first cost is thirty to one hundred per cent higher than that of the less efficient oil engine, a high use factor will frequently make its operating cost per horsepower well under that of any other prime mover. If a Diesel operates ten hours a day for 360 days yearly, the fuel saving compared with an engine using twenty-five per cent more fuel would be sufficient to meet the overhead charges on an additional first cost of sixty dollars per horsepower.

Saving in lubrication charges would probably offer still more inducements. Obviously, there is a use factor at which, with the two types of engines possessing equal structural merits, the engines are on an equality. At low use factors the surface-ignition engine offers more inducements.

The manufacture of small-powdered Diesels is essentially an American industry. While European firms have built small engines, their output does not, in percentage of the total Diesels manufactured, compare with the number of engines of less than one hundred and fifty horsepower manufactured in the United States. Here several firms have devoted most of their efforts toward perfecting the small unit.

On first thought it would appear that in this country, where power plants are as a rule larger than the European plants, the demand would be for larger units. It is usual to associate a high use factor with large power plants. However, owing to the vastness of the United States, many small establishments far removed from congested centers have a high use factor for their plants. This is notably true of the mining industry as well as irrigation in the Southwest. Likewise, hundreds of small central stations are scattered over the country and have a fairly good load for all months of the year. It would seem, then, that the small-powered Diesel is a logical answer to the insistent demand for cheaper power. With the engine simplified to meet the operating ability of the small-plant engineer, there is no reason to question its advantages.

Mr. Hoover Resigns

THE resignation of Mr. Hoover from the presidency of the Federated American Engineering Societies is unfortunate, but was apparently unavoidable. He felt that as an executive officer of the Government he could not direct the activities of a body that seeks to influence legislation even though he was in accord with the legislation sought. The engineering profession will have to accept his action with the philosophic thought that of the two positions that of Secretary of Commerce gives him the larger opportunity for public service.

Engineers must be unselfish enough to give up Mr. Hoover graciously from their own needs to the greater needs of the National Government. In the long run, too, his increasing eminence will redound to the benefit of all engineers. The outstanding success of one engineer is good for the whole profession. It is in such a spirit that the present situation must be accepted.

There is no reason why the Federation should not "carry on" as successfully as it has started. Under Mr. Hoover's able guidance it has passed through its organization stage, has reached a stable position and has begun to function as a body of considerable influence and prestige. While it was to be desired that the organization's first brilliant president should continue to lead it ahead, the critical period has been passed with his help and its future success is assured.

A few years ago, in a spirit of farsightedness, the Navy Department reserved for itself certain oil lands in the West, much to the displeasure at the time of some oil interests and their ever-faithful friends in Congress. Up to the present these tracts have been held intact as an insurance against future shortage, but it now appears that the Department has awakened to the fact that it is likely to find itself in possession of vast tracts of dry land due to the subterranean encroachments of its neighbors. It therefore has seen fit to adopt a policy of protection through the sinking of a number of wells on its reserves. True to its traditions, the Navy has yet to be caught napping.

The Chicago Drainage Commission has chosen Diesel engines for the Calumet Power Station. The plant will consist of four seven-hundred-and-fifty-horsepower Busch-Sulzer two-stroke cycle Diesels direct-connected to alternating-current generators. *Power* will carry a description of this plant, which has some very unusual features, in an early issue.

CORRESPONDENCE

Are Small Boiler Tubes Desirable?

Regarding the use of large and small boiler tubes let us note the performance of the different-sized tubes. Take, for instance, a 4-in. tube in a horizontal return-tubular boiler, 16 ft. long. As the hot gases pass through these tubes, only such as come in contact with the tube surfaces will transmit heat to the water, and the hot gases that pass through the center of the tube are lost, as far as transmitting heat to the water in the boiler is concerned.

Large tubes will not become stopped up with soot and ashes so easily as small ones. They also will not sag so easily, being made of thicker metal, and fewer tubes can be used in a boiler of a given size, but there will be less tube-heating surface than if more and smaller tubes were used. On the other hand, small tubes will have less lost heat through their centers than the larger ones. Small tubes are more easily choked and when badly stopped up with soot give up comparatively little heat. Small tubes are thinner than larger ones, and although they will communicate heat to the water quicker than large tubes, they are more likely to sag.

As to circulation I have found no difference when using 4-in. and 2½-in. tubes, if placed in vertical rows and a space left between the center rows. But another trouble with small tubes is scale, as they are very close together. I have removed tubes when the scale was solid between them. Small tubes will reduce the water space of the boiler.

The steam space will remain the same if the small tubes are placed no higher in the shell than the large ones, but the steam will fluctuate unless the firing is done very carefully, because there will be a smaller volume of water in the boiler to hold the heat. Therefore steam will rise rapidly and it will drop quickly. I would not recommend small tubes in a boiler for the reasons mentioned.

Small tubes will increase the heating surface of the boiler and consequently its rated capacity. The fuel used will have a great deal to do with the efficiency of the small tubes. Where rich yellow pine or soft coal is used, small tubes will cause more trouble and expense to keep them clean than will be gained in output over large tubes. Very small tubes get choked up with soot and ashes. I have had to weld a bit to a rod and bore out 1-in. tubes, which is very slow work when it must be done by hand with several hundred tubes to bore. Of course a good draft will help to some extent to keep a small tube clean.

FRED E. CUPPER.

Jacksonville, Fla.

Wood Pulp in Boiler-Feed Water

When I broke into the engineering game, I was a twenty-dollar-a-month asylum attendant. I had nothing and knew nothing about the business. If anyone had handed me a globe valve and asked regarding its use, I could not have told. Since that time I have spent many hours studying the business of engineering, working twelve hours a day, seven days a week, and setting up nights trying to grasp the fundamental principles of the business; even now I barely know enough to earn my bread and butter. Of course I might have done as they do in some states where almost every engineer and fireman has his farm, and that is his life and business. The job he holds as a fireman is a secondary affair, something by which he makes a little extra cash in his spare time.

Last spring my employers sent me to investigate a boiler accident. I found that a fireman, in the absence of his chief engineer, had opened a valve in a line from the service pumps that delivered water to the digesters and had turned this water, containing about 60 per cent wood pulp, into the boilers. By the time he had discovered what he had done, every water pipe to the boilers was plugged, and a boiler carrying a 100 per cent overload, with stokers and force draft working full blast, will last but a short time under such conditions.

When I crawled into the boiler and cleaned out about six barrels of pulp, I found that the lower tubes in the middle and front drums were practically holding by $\frac{1}{16}$ in. of metal in the plate. It is easy to imagine what would have happened to the ten men employed in this boiler room if those tubes had pulled out of the sheets with 150-lb. superheated steam from five boilers tearing back through the damaged boiler. I figured it out that there would have been about ten widows in the town.

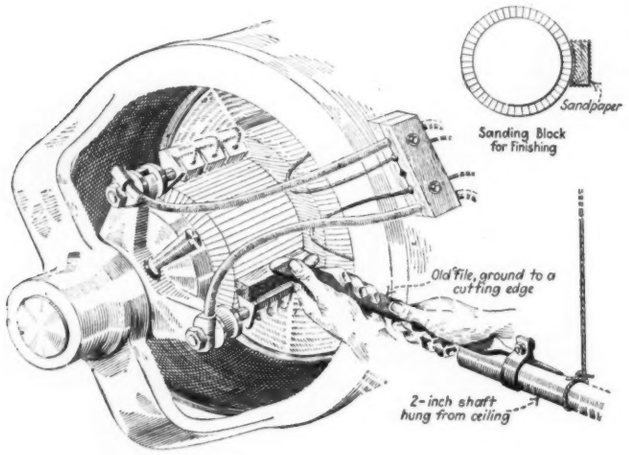
The loss of this boiler cut the plant's production about 10 per cent, a number of men were thrown out of work, and five weeks were spent in getting the boiler into a condition so that it could be run. Approximately, the loss was about $250 per day, the men out of work lost their pay, and in the end we have an inferior boiler.

All this because a fireman did not know his business. No fireman has a right to tamper with valves not directly relating to his work. Furthermore, a reliable engineer would not allow a dangerous condition, such as mentioned, to exist inconnection with his boilers.

South Quincy, Mass. A. P. WOOD.

Turning Down a Commutator Without Shutting Down

The commutator of a small direct-current generator had been allowed to spark through neglect until it was burned too deeply to be sandpapered out. The machine could not be spared for turning down for four days, and it began to look as if it would have to be treated every minute for that length of time with a stick of compound and a sheet of sandpaper, in order to pull it through to the end of the run.



TURNING DOWN THE COMMUTATOR OF A GENERATOR OPERATING UNDER FULL LOAD

"Necessity is the mother of invention," and I thought of turning down the commutator with the machine under load, but had neither a traveling tool post nor a place on the machine to hold it, the brush-holder yokes being all in use. So I made a small rectangular hardwood block about 2 x 2 in. and as long as the commutator was wide, taking care to have it perfectly square. This I laid against the face of the commutator, resting on and fastened to a row of brush holders, the top of which was just 2 in. below the center line of the falling side of the commutator. Outside the brushes on each side was a strip of commutator that was not worn or deformed, and this gave a true bearing surface for the block. I next took a flat file and ground it to form a cutting tool, as shown in the illustration. The cutting edge was rounded to avoid digging circular grooves in the surface; this also gave a lot of cutting edge, making it possible to shift to a new sharp location as one part became dulled by the very high speed at which the cutting had to be done, the operating speed being 1,150 r.p.m. By gripping the tool firmly in the hands and using the hardwood block both as a tool rest and a guide against which to rest the forefinger, I found that I could shift the tool across the commutator face and do a very fair job. One fault soon showed up in that the light file tended to rebound from the blow of the high spots, and when pressure was applied to prevent this, the file tended to follow into the low spots. I then took a piece of old 2-in. shafting about 4 ft. in length to use as a heavy handle, to the end of which I clamped the file with a 2-in. hose-coupling clamp. This piece of shafting I suspended from the ceiling by its middle, by a long rope so that the tool edge hung close to the middle of the commutator face, as shown in the illustration. This left the tool bar perfectly free for manipulation, and I was surprised to find how nicely a light cut could be shaved off the commutator surface, the tool showing no tendency to follow the high and low spots. I was, however, compelled to put on goggles, as the fine cuttings came up from the point of the file as if blown from a nozzle, owing to the high cutting speed; and I found also that great care had to be used in bringing the tool up to the running surface, owing to the weight of shafting behind it.

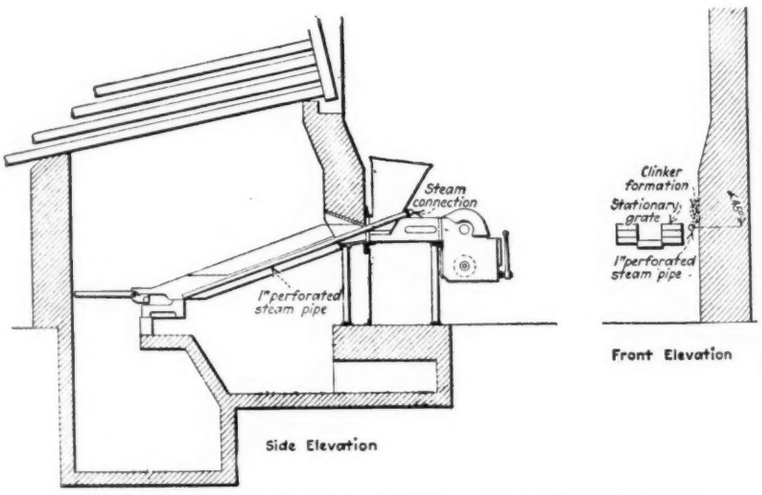
For a finish I cut a second block of wood about half as long as the commutator and hollowed out one side of it to fit the commutator surface, as shown in the upper right-hand corner of the figure. Around this block I wrapped first coarse and then fine sandpaper, and by moving this sanding block back and forth across the commutator face, I soon had as perfect a surface as I ever received from a machine shop.

The whole job was done in three hours, and the machine carried full load all the time. This was five months ago and the commutator is sparkless yet.

Vancouver, B. C., Canada. R. MANLY ORR.

Clinker Crystallizing Kink

I have had wonderful success since installing the perforated steam pipe, as illustrated, to discharge steam against the fire walls of my underfeed-stoker furnaces. The principle of this steam application is that it crystallizes the clinker and it takes less exertion on the part of the men to break it off the brickwork. It also greatly reduces the time that the clean-out doors are open, thus admitting a minimum amount of air into the furnace during the fire-cleaning period. Besides reducing the repair work to the brick side walls of the boiler, it allows the firemen to carry a practically constant CO_2 with but little variation, due to the clean-out doors being open a minimum period, thus keeping out excess air.



SIDE AND END VIEW OF CLINKER-CRYSTALLIZING PIPE

There is very little cost for repair, the pipe being replaced about once a month. This is easily done and the perforated pipe can be made ready for use in advance.

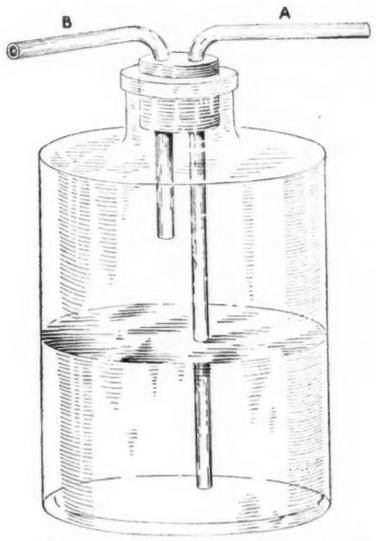
A. S. BAKER.

Philadelphia, Pa.

Detecting Ammonia Leaks

The writer offers the suggestion contained herein, believing that it will be helpful to some of the readers of *Power*.

The detection of ammonia leaks in refrigerating plants by means of sulphur candles has long been standard practice. It was only the lack of such candles when they were badly needed that led to a search for some other means of testing. The resulting device, described herein, proved decidedly superior to the sulphur method.



AMMONIA DETECTING DEVICE

As shown in the sketch, a bottle is fitted with a two-hole rubber stopper and two glass tubes. The liquid in the bottle is a dilute solution of hydrochloric acid (HCl). By blowing in tube *A*, HCl vapor is driven out of the tube *B*. In the presence of ammonia this forms a white "smoke," NH_4Cl. With this device no flame is present, there is no odor, and the tube *B* can be made long enough to reach otherwise inaccessible spots and will detect the most minute leak. The acid solution may be very dilute, and will last indefinitely.

Possibly this idea has been used before, but I have never happened to hear of it. J. W. GAVETT,
Assistant Professor of Heat Power
Ithaca, N. Y. Engineering, Cornell University.

Felling a Chimney

I have read with interest "The Mossback" foreword, on page 375 of the March 8 issue, and it is all right. However, I wish to say a few words concerning it, in connection with the article on felling a chimney, page 378 of the same issue.

If any engineer had prophesied four years ago that in 1921 those four self-supporting stacks of modern design and construction would be in the scrap heap, he would have been voted into the chair as presiding officer of all the mossbacks in the United States and given a leather medal.

The stacks are gone, nevertheless, while a good old-fashioned brick chimney, standing within a few rods of my present plant, but not a part of it, was built so long ago that I cannot remember when it was not there, and it seems to be good for many years more.

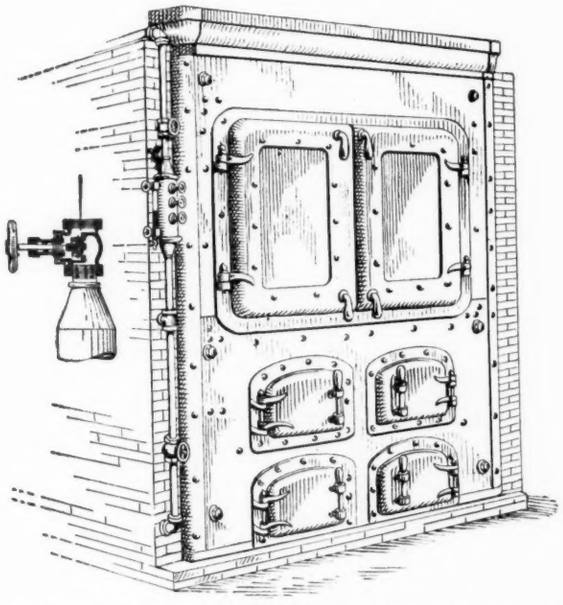
The brick chimney in my own plant has survived for 27 years, and appears to be good for 27 years more, yet there are people in the world who would vote me into office as vice president of the aforementioned coterie if I should claim that the old-fashioned brick chimney is superior to the modern self-supporting steel stack. W. H. WAKEMAN.

New Haven, Conn.

Valve in Water-Column Connection Caused Boiler Rupture

A recent accident to a high-pressure boiler of the return-tubular type, which came to my attention a short time ago, is interesting from the lesson it teaches. The boiler was one of four in a large industrial plant of this city, and was fired up one night with low water until the middle section finally ruptured just below the longitudinal seam. The boiler was totally ruined, but fortunately it did not explode. The fusible plug at the rear head blew out, but the noise from equipment in the boiler room evidently drowned the warning of the escaping steam.

An investigation disclosed that a shutoff valve of the globe type in the steam pipe to the top of the water column had been put in the wrong way; that is, with the steam coming from the boiler on the top of the valve disc. This disc had dropped off, and when the boiler was fired up for the night run, the pressure held the disc tight, thus closing the valve, while the pressure from below forced the water up in the glass.


ENLARGED VIEW SHOWS HOW VALVE WAS PUT IN WATER-COLUMN CONNECTION

It appears to me that this accident serves to emphasize the necessity of keeping water-column piping free of valves. It is also apparent that if fusible plugs are to be depended on, they should be placed in such a manner that there is no question of their not being heard at the critical time.

New Orleans, La. CHARLES P. WHITTY.

Installing the Proper Trap

The engineer was in need of a trap to install with some new equipment, and had been informed that a certain size of trap was required. The plant was equipped with a closed feed-water heater and the new demand for steam would make a heavy draft on the boiler output. He knew that returning the condensation from the new coils directly to the boilers would effect a considerable economy and that traps that will do this are to be had. He got out his catalogs and studied the illustrations and description of a trap that looked good to him, but failed to note whether it was a return trap or otherwise.

He placed an order, and when the trap arrived looked it over and began to have misgivings that it was going to "lay down" on the job.

He read the description again and his face brightened as he read: "This trap has a nominal lift of two feet for each pound effective steam pressure," which was reassuring. He made a rough mental calculation: "Let's see. Water weighs a little less than half a pound to the foot and two feet to the pound of steam; that leaves a little balance in favor of the steam, enough I suppose to overcome friction, so it's all right."

When he installed the trap, he found that it would not do the thing he expected of it, and his first impulse was naturally to blame the maker of the trap, but the fault lay only with himself. He had made the not uncommon error of not understanding what he had read, although he honestly thought he had.

If he understood that "steam trap" meant simply a device that would trap the steam, but allow the water to escape, and that effective pressure meant the pressure within the trap at the discharge and not the boiler pressure two hundred feet distant, he would have seen where the fault lay.

The type of trap to install to meet best a given set of conditions should receive careful consideration on the part of the engineer who will be responsible for its future performance. I do not favor using a trap that operates on the thermostatic principle on a line subject to any considerable variation of steam pressure, because, depending, as it does, upon temperature change, it is essential that this range be kept within narrow limits for reliable service.

Take the case of a plant operating one turn only, with an average day steam pressure of 125 lb., while at night the pressure may go as low as 50 lb. The temperature of the steam for 125 lb. gage will be 352.8 deg., and for 50 lb., 297.8 deg., a variation of 55 deg. Should the trap be adjusted to satisfy the working conditions at the higher pressure and temperature, it will not close tight at the lower, and if adjusted to take care of the night conditions, it will be sluggish or not work at all at the higher pressure. For this reason a trap working on the temperature-change principle should preferably be used only on a line that is supplied through a pressure-regulating valve, thus securing a practically uniform temperature. A trap of this class has little storage capacity and, when of proper size and in good condition, will continuously discharge the condensate and can be depended on to give good service when installed as outlined.

The gravity type of trap possesses considerable storage capacity and depends only upon the amount of its contents for discharge. For this reason it is well adopted for draining mains, separators, etc.

Take the case of a priming or overfilled boiler. There is a sudden rush of a considerable quantity of highly heated water entering the trap from the line or separator, and time is a factor in this case. The discharge of this water at once begins. With the thermostatic type, it may be conceived that with the sudden advent of a slug of water, the trap may actually close until the water has cooled down to the trap setting.

The best guarantee of good trap service is inspection at regular intervals. For this reason, each trap should be provided with a bypass connection and some attempt made to place the trap in an accessible position, two simple aids to good service that are frequently neglected.

In a recent contribution to *Power* on the subject of traps A. C. McHugh takes the view that it is better to carry spares and replace traps out of order than to employ the bypass plan. In special cases such as he cites this may seem the more desirable, but for a general practice it is objectionable for the following reasons:

First, because in a plant of any considerable size, quite a number of traps, varying in capacity and make, may be in service. Standardizing on one make and a limited range of sizes would help. Second, a bypass permits keeping the line drained while repairs are under way, for it should be borne in mind that a "cold" trap is a menace that may bring disaster quickly, especially on separator service. O. B. CRITCHLOW.

Bellingham, Wash.

Oil Filter in Refrigerating Plant Fails to Work

On a recent visit to inspect and adjust a refrigerating plant, I came across one of those conditions that puzzle the best of engineers. The trouble was in the gravity oiling system of a 300-ton horizontal duplex ammonia compressor.

The oil filter and reservoir were elevated about three feet above the machine. A pipe with a globe valve led from the bottom of the reservoir to the several sight-feed oil cups. The oil then drained into the crankpit, from which it was lifted by a pump to the filter.

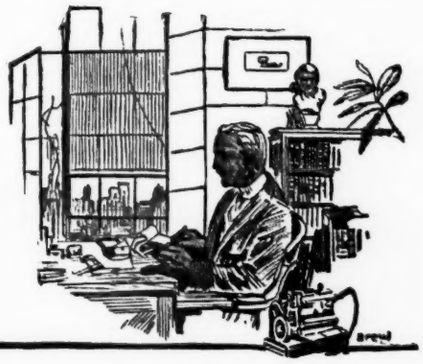
When the compressor was shut down for the idle season, the oil was removed. On starting up, the filter was refilled and the globe valve opened. No oil appeared at the sight-feed cups. We tried the filter drain cock, but no oil appeared here either. Disconnecting the drain pipe, the filter was again emptied and we found to our surprise a hard white deposit which was much like fine sand. Upon investigation we learned that during the busy season a compressor bearing had run hot and the engineer had put sulphur in the bearing to cool it off. This sulphur, as long as the oil was in constant circulation, was carried in solution even through the filter cloths. When the plant was shut down, the sulphur promptly settled in the tank and piping.

The moral, if one wishes to draw one, is that sulphur should never be used to cool hot bearings. The cause of heating should be discovered and removed.

New York City. FRED. A. CLEMENS.

Blowoff lines are water wasters. It is almost a necessity to have two valves on every blowoff line. Using this combination, it is possible to keep one valve tight at all times, and the saving in coal will pay for the extra valve.

INQUIRIES OF GENERAL INTEREST



Pipe Joints for Ammonia Systems—Is it more advisable to use screwed or welded joints in ammonia systems? W. F. L.

Welded joints are preferable, but screw joints are sufficient if the pipe is sweated into recessed fittings.

Heat Number Stamped on Boiler Material—What is meant by "heat number" stamped on boiler material? L. W. R.

The heat number is the melt or slab number stamped on the material and test specimens by the manufacturer for indentification from his records of details of the manufacture, analysis and tests of the material.

Testing Equality of Piston Clearance—How is it determined whether an engine connecting rod is of correct length to give equal clearance in each end of the cylinder? J. N. E.

Make a mark on the crosshead and corresponding marks on the guide when the piston is first at one end and then at the other end of the stroke. Then disconnect the connecting rod and move the crosshead so the piston strikes against first one end and then the other end of the cylinder, each time making a mark on the guide opposite to the mark on the crosshead. In each instance the distance between the marks made with the piston in the same end of the cylinder will be the piston clearance in that end when the connecting rod is connected up. These distances can be compared by taking the length of one of them with a pair of dividers and setting it off over the other distance.

Conversion of Hot Water to Steam at Lower Pressure—If water at the pressure of 500 lb. gage and temperature of evaporation for that pressure is discharged through a pressure-reducing valve so the pressure is reduced to 50 lb. gage, what percentage of the water will be converted into steam at the reduced pressure? G. W. S.

Each pound of water at the pressure of 500 lb. gage, or 515 lb. per sq.in. absolute, would contain 451.6 B.t.u. above 32 deg. F. Neglecting the loss of heat from radiation, the same quantity of heat would be delivered per pound after passing through the reducing valve. For a pound of dry saturated steam at 50 lb. gage, or 65 absolute, the heat of the liquid is 267.5 B.t.u. above 32 deg. F. and the latent heat of evaporation is 911 B.t.u., and as each pound of the mixture would contain but 451.6 B.t.u., the fraction converted into dry saturated steam would be

$$\frac{451.6 - 267.5 \times 100}{911} = 20.2 \textit{ per cent.}$$

Setting Steam Valve of Duplex Pump—What is the method of setting the steam valves of a duplex boiler-feed pump? W. H.

First place the pistons at the center of the stroke. Move them first to contact with one head and then to the other, each time making a mark on the piston rods against the stuffing-box glands. Then place a mark on each rod midway between the contact marks and move each rod until the central marks come against the end of the glands. The pistons then will be in central position and the valve-motion arms should stand perpendicular to the rods; and if that is not true for either side of the pump, then the crosshead or spool must be disconnected and its position corrected. Next, remove the steam-chest covers, place the slide valves centrally over the ports and adjust the lost motion of each valve so it will have the same clearance at both ends of the valve or at either end of the lost-motion link. The total lost motion may be made equal to about $\frac{3}{16}$ of the travel of the valve rod at contact stroke and can subsequently be adjusted if the pump does not work properly. Before replacing the steam-chest cover, move over one of the valves to open a steam port so the pump will start off for admission of steam to the steam chest.

Cost of Steam, Using Different Coals—Assuming generation of dry saturated steam and the same skill of firing in each case, what is the relative cost of steam for coal and removal of ashes, using coal No. 1 and No. 2 under the following conditions?

	No. 1	No. 2
Total coal fired	6,380	8,020
Total clinker and ash	1,288	847
Total water evaporated	39,720	52,410
Average temperature of feed water, deg. F.	71.8	85.5
Average steam pressure (gage)	142	148
Price of coal per ton (2,000 lb.)	$5.75	$6.20
Cost of removing ashes per ton (2,000 lb.)	$0.25	$0.25

J. J. F.

When using the No. 1 coal, the evaporation under actual conditions was 39,720 ÷ 6,380 = 6.226 lb. of water per pound of coal. The total heat of steam at 142 lb. gage, or 142 + 15 = 157 lb. absolute, is 1,194.2 above 32 deg. F. and the factor of evaporation is (1,194.2 − 71.8 + 32) ÷ 970.4 = 1.1896 and the equivalent evaporation was 6.226 × 1.1896 = 7.406 lb. of water evaporated from and at 212 deg. F. per pound of coal.

The cost of coal and removal of ashes amounted to $\frac{\$5.75}{2,000} + \left(\frac{1,288}{6,388} \times \frac{\$0.25}{2,000}\right) = \$0.0029$ per pound of coal used, and the cost for equivalent evaporation from and at 212 deg. F. per 1,000 lb. of steam would be 1,000 × $0.0029 ÷ 7.406 = $0.391.

When using the No. 2 coal with steam generated at the pressure of 148 lb. gage, or 148 + 15 = 163 lb. per sq.in. absolute, the total heat per pound of steam generated was 1,194.8 B.t.u. above 32 deg. F., and the cost of equivalent evaporation per 1,000 lb. of steam from and at 212 deg. F. would be,

$$1,000\left[\frac{\$6.20}{2,000} + \left(\frac{847}{8,020} \times \frac{\$0.25}{2,000}\right)\right] \div \left[\frac{52,410}{8,020} \times \frac{1194.8 - 85.5 + 32}{970.4}\right] = \$0.405$$

Hence, using coal No. 2 costs $\frac{0.405 - 0.391}{0.391} \times 100 = 3.58$ per cent more than to use coal No. 1.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses.—Editor.]

Editor of "Mechanical Engineering" Dies

Thirteen years of service as editor of *Mechanical Engineering*, the journal of the American Society of Mechanical Engineers, came to an end on April 18, when Lester Gray French died at the French Hospital in New York City from septic poisoning following an operation. Mr. French served also, during part of this period, in capacity of assistant secretary of the society. He had been a member since 1899, when he was elected a junior. It was not until 1912 that he became a full member.

LESTER GRAY FRENCH

Mr. French was born in Keene, N. H., in April, 1869, and received his technical education at the Massachusetts Institute of Technology, from which he was graduated in 1891 with the degree of B.S. After about a year with the Cranston Printing Press Co. as draftsman, he became connected with the International Correspondence Schools, Scranton, Pa., as instructor in mechanical engineering. He left this institution in 1895 and went to Providence, R. I., where he entered the employment of the Builders Iron Foundry as assistant to the superintendent. In 1897 he became editor in chief of *Machinery*, continuing in this position until 1906, when he resigned to take up the publication of technical books. He was the author of one of the earliest American treatises on the steam turbine. In 1908 he was given the position of editor of the publications of the American Society of Mechanical Engineers, which he held up to the time of his death. He was a member of the Engineers' Club of New York and the University Club of White Plains, where he lived. He leaves a wife and a son and daughter.

Present-Day Limitations of Oil Circuit Breakers*

In view of the indefinite information regarding requirements and limitations of Oil Circuit Breakers, the Protective Devices Committee of the A.I.E.E., the Apparatus Committee of the N.E.L.A. and the Power Switchboard and Oil Circuit Breaker Section of the Electric Power Club co-operated in sending out a joint questionnaire on the subject to the larger operating companies. From the answers to this move, the principal defects and requirements of modern oil circuit breakers were deduced and classed under four heads: Rated voltage, rated continuous current-carrying capacity, rated momentary current-carrying capacity, rated interrupting capacity.

Rated Voltage.—Voltage troubles encountered in practice are due to vaporizing of the oil, which causes serious explosions, or to breakdown of bushings or insulating material. It would seem that the present test requirements, as specified by the A.I.E.E. standards, of 2.25 times operating voltage plus 2,000 volts, are too low. The tests are made under the best possible conditions, whereas in practice dirt, moisture, gases having poorer insulating qualities than pure air, and moisture in the oil put the breaker at a severe disadvantage. Furthermore, transient voltages encountered in every-day practice, as in sychronizing for instance, will normally reach twice the rated voltage and may rise considerably above this value. Therefore the test voltage of the A.I.E.E. standard should be raised.

Rated Continuous Current-Carrying Capacity. — Little trouble has been encountered in this line, except overheating of parts through poor workmanship, such as poor alignment of contacts. These should be made more easily and permanently adjustable. Ventilation of switch compartments is strongly advocated, incidentally as a means of reducing maximum temperatures, but primarily to prevent the accumulation of explosive gases.

Rated Momentary Current-Carrying Capacity. — Trouble has been experienced by some of the larger operating companies through failure of oil circuit breakers to carry heavy short-circuit currents for the time necessary to open the circuit, due to inability of the current-carrying parts to withstand the electromagnetic strains. It is recommended that breakers be given a short-circuit rating for both one second and five seconds, which should be at least equal to the interrupting capacity, and in most cases two or three times this value. Manufacturers should apply careful tests to their products to determine the ability of the different parts to withstand these heavy currents, including the auxiliary contacts.

Rated Interrupting Capacity.—The limiting factors governing the interrupting capacity of a breaker have never been conclusively determined. The present-day practice of rating oil breakers to interrupt a given r.m.s. current at normal voltage two times in two minutes, and be in condition to close again and carry full-load current is considerably below operating requirements; on some systems where continuity of service is of great importance, it may be necessary to throw in the breaker as many as four or five times in quick succession in the effort to restore service. It is therefore recommended that breakers be given a rating on a single-shot basis, with proportionally lower ratings for a two-shot, three-shot or four-shot basis. In this connection it is suggested that the time necessary for interruption and the resistance and reactance of the circuit should be considered, reactance in particular decreasing the interrupting capacity. It has, furthermore, been almost unanimously found advisable to vent the tanks.

*Abstract of report by Sub-Committee on Oil Circuit Breakers and Switches of the Protective Devices Committee of the A. I. E. E. read by H. R. Woodrow, chairman, at the ninth midwinter convention of the A. I. E. E.

The Theory of Relativity

Professor Einstein, of the University of Berlin, delivered his second lecture on the Theory of Relativity in Doremus Hall, at the College of the City of New York, on Wednesday afternoon, April 20, before an appreciative audience.

After stating that there are many kinds of motion in the universe and that we have no right to assume that nature necessarily favors those with which we are most familiar, Professor Einstein spoke of the gravitational and other external influences upon the motion of a point, the passing of time and the travel of light with respect to an assumed system of co-ordinates.

Touching upon surface measurement, he stated that the theory of summation of differential areas could not be applied with exactness to curved surfaces.

With respect to the universe the professor claimed that if this is assumed to be infinite then we cannot consider the ether as matter, but must believe it to be a total void in which the stars are contained. If, on the other hand, we consider ether as matter and that together with the stars it makes up the universe, then there must be a finite limitation to its dimensions. So far it has not been proved which of the two cases is true.

The Locomotive Boiler Code recently adopted by the Council of the American Society of Mechanical Engineers was devised to meet the needs of the great number of locomotives in use on the industrial and short-line railroads within the various states. These boilers are, of course, outside the control of the Interstate Commerce Commission. The Code is a part of the A.S.M.E. Boiler Code itself and follows the same general form.

The manufacture of portland cement on a large scale is contemplated in Brazil. It is proposed to use waterfalls for power and charcoal as fuel.

Herbert Hoover Resigns at F. A. E. S. Council Meeting

Mr. Hoover is no longer president of the Federated American Engineering Societies, having resigned at the council meeting in Philadelphia on April 16. He explained his action by pointing out that it would not be proper for him, as a member of the executive branch of the Government, to remain at the head of an organization that is necessarily active in either furthering or opposing legislation of various kinds; one of the chief objects of the federation is, of course, to influence legislative action. A resolution was voted expressing the council's regret at Mr. Hoover's retirement and appreciation of his help in carrying the organization through the difficult formative period.

A number of other matters were handled at the meeting, and several encouraging committee reports were received. The council's next meeting is to be on June 3,

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HON. HERBERT HOOVER RECEIVING CERTIFICATE OF HONORARY MEMBERSHIP IN THE ENGINEERS' CLUB OF PHILADEPHIA FROM GUILLIAEM AERTSEN, THE PRESIDENT

when it is hoped that the report on elimination of waste in industry will be presented.

The meeting was held at the Engineers' Club of Philadelphia, and that organization gave a large dinner in Mr. Hoover's honor in the evening, when more than 600 were present. Guilliaem Aertsen, president of the club, made a speech in which he praised Mr. Hoover most highly and then presented him with a certificate of honorary membership in the Engineers' Club of Philadelphia. Mr. Hoover then made his address, which was the feature of the evening. He made a strong plea for governmental reorganization, saying:

To any student of Federal organization one sweeping and fundamental necessity stands out above all others, and that is that the administrative units of the Government must be regrouped so as to give each of the great departments more nearly a single purpose. The hodge-podge of aims in certain administrative branches is scarcely believable when we consider our national pride and skill in organization. Such functions as public domain, public works, assistance to veterans, public-health functions, aids to navigation, to industry, to trade, purchasing of major supplies, are each and every one scattered over from four to eight departments, most of which are devoted to some other major purpose.

Other speakers included George Wharton Pepper, Colonel William A. Glasgow, John C. Trautwine, Jr., and Dean Dexter S. Kimball, vice-president of the council.

Dean Kimball took as his subject the federation itself, analyzing the need for such an organization and explaining its ideals and possibilities. In summing up he said: "The functions of such a society will differentiate sharply from those of an individual society in that the individual society is more likely to deal with service to the individual. This society is organized for service to the nation. It is a challenge to national service. There is no question in my mind that it has a bright future and is worthy of the support of engineers of all kinds and in all places."

From Our Berlin Correspondent

Public opinion regarding the ownership of public utilities is undergoing a reaction in Germany because of financial considerations. It was hoped that the socialization or communizing of public-utility works would result not only in more efficient service, but to a considerable extent in doing away with labor troubles, but such does not seem to have been the case. Municipalities are experiencing trouble in financing publicly owned properties, especially street railways requiring under present conditions a considerable outlay for repairs and betterments or meeting periods of business depression.

Several town councils are considering the advisability of reorganizing their public-utility works in such a way that it will be feasible to call in the co-operation of private capital. The socalled "mixed economic company," composed partly of public bodies like communes or municipalities, and partly of private capitalists, is gaining more and more favor in this connection and is believed to be the best solution of the difficulty. In case of the street-railway systems of Frankfort and Berlin it is believed that if this procedure is not followed in the near future, it will be because of political opposition.

An interesting instance of the use of this form of financial organization for public-utility work is afforded by the Bavarian states in the formation of two companies for building large hydro-electric plants, the Walchensee and the Isar, the latter requiring an outlay of something like 600,000,000 marks. The capital stock of such companies is usually only a small part of actual cash requirements, while the main portion of capital is raised by loan issues, the interest of which is guaranteed by the state.

Interest in the development of waterways and hydro-electric projects is active, the largest being the plan to connect the Rhine-Main-Danube, now actually authorized by the German Parliament after lying dormant almost half a century. The opening up of the Neckar Canal to shipping traffic is now under financial organization, as are also hydro-electric plants for the River Saale and the Upper Rhine. There is, however, an element of distrust in regard to the too great development of waterways and hydro-electric power plants, due to the fear that railroad systems will be neglected.

A considerable increase in rates was obviated through the use of oil fuel under the boilers of the Narragansett Electric Lighting Co., Providence, R. I., according to the company's 1920 report. It is stated that by the end of the year 65 per cent of the plant's output was produced by oil fuel, although the boilers that are using oil are being equipped with stokers to permit of a quick return to coal if desired. The greater economy in the use of oil is ascribed to the recent abnormally high coal prices and the reduction of labor in handling and storing coal.

Concessions of water-power plants in Switzerland to individuals are valid for only 80 years, at the end of which time the government may take them over. Many plants, however, are owned by communities, and some of the cantons own all the power plants in their territory.

Washington News

New Coal Control Bill Comes to the Fore—Assigned Car Question To Be Taken Up—Supreme Court Justifies Right of Congress To Control Necessities—Water-Power Applications Received

By Paul Wooton
Washington Correspondent

In a revised draft of his Coal Commissioner bill, Senator Frelinghuysen designates the Director of the United States Geological Survey as Federal coal commissioner. The duties prescribed for the coal commissioner are to be in addition to those of director of the United States Geological Survey, and an additional salary of $5,000 is provided. Incidentally, this plan does not follow the ideas of Dr. George Otis Smith, the director of the Survey. He believes that recommendations as to remedies and regulation should be undertaken by an agency entirely separate from that which conducts fact finding. His idea is that the powers conferred by the bill should be vested in the Secretary of the Interior, who could assign the duties to the agencies best fitted to handle the work.

The Frelinghuysen bill, while much less drastic in its provisions and less comprehensive in its scope than the Calder bill, provides for a searching investigation into every phase of the coal trade and prescribes penalties for refusal to comply with its provisions. The coal commission is to have the full right of subpœna and may compel personal appearance or the production of documentary evidence at any point in the United States. In addition to reporting to Congress the results of the various investigations authorized by the bill, the commissioner is to make "such recommendations for further legislation relating to the mining, distribution, transportation or sale of coal as he may deem necessary."

Assigned Cars To Be Discussed

The railroads, the coal operators, the public utilities, large consumers and others interested in the coal trade are making careful preparation for the hearing to be conducted by the Interstate Commerce Commission on the assigned-car question.

There has been strenuous opposition on the part of coal operators to the giving of assigned cars for the handling of railroad fuel. It is alleged that this gives the railroads an unfair advantage in price negotiations, often resulting in their obtaining coal below the cost of production. This is said to have the effect of increasing the price of coal to other consumers, since the operator must rely on that portion of his sales alone for his profit. The public utilities believe that they are in the same category as the railroads and take the position that they are entitled to assigned cars as much as are the railroads.

Federal Control Upheld

In holding the District of Columbia rent law constitutional, the United States Supreme Court, on April 18, upheld the right of Congress to control necessities of life when charged with the public interest. In the course of the majority opinion of the court Justice Holmes said:

> The fact that tangible property is also visible tends to give a rigidity to our conception of our rights in it that we do not attach to other less concretely clothed. But the notion that the former are exempt from the legislative modification required from time to time in civilized life is contradicted, not only by the doctrine of eminent domain, under which what is taken is paid for, but by that of the police power in its proper sense, under which property rights may be cut down and to that extent taken without pay.
>
> We do not perceive any reason for denying the justification held good in the foregoing cases to a law limiting the property right now in question if the public exigency requires that.

Water Power Applications

Two applications were received by the Federal Power Commission during the week ended April 16. The Kelly Mines Co., L. C. Smith Bldg., Seattle, Wash., applied for a preliminary permit to cover a diversion from Fishhook Creek and Little Susitna River, in Alaska, to a common power house 55 miles north of Anchorage. Three thousand horsepower is involved, which is to be used for power purposes in the conduct of mining and milling operations. The George Inlet Packing Co., Peninsula National Bank Bldg., Portland, Ore., has applied for a license to cover a constructed pipe line which diverts water from Beaver Falls Creek to a canning factory on George Inlet, twelve miles from Ketchikan, Alaska.

Engineers To Visit England

To award the John Fritz Medal to Sir Robert Hadfield at the opening meeting of the British Institution of Civil Engineers on June 29 and to express the friendly greetings of American engineers to those of Great Britain, a delegation representative of the four founder societies will go to England this summer. The men who will make the trip and the societies they represent are as follows: Charles T. Main, of Boston, the American Society of Civil Engineers; Col. Arthur S. Dwight, of New York, the American Institute of Mining and Metallurgical Engineers; Ambrose Swasey, of Cleveland, the John Fritz Medal Board of Award and the American Society of Mechanical Engineers; Dr. F. B. Jewett, of New York, the American Institute of Electrical Engineers. Dr. Ira N. Hollis, president of Worcester Polytechnic Institute and past president of the American Society of Mechanical Engineers, will accompany the deputation and bear the message from the American engineers.

The John Fritz Medal is a gold medal presented for achievement in applied science as a memorial to the engineer whose name it bears. Previous recipients have been John Fritz, Lord Kelvin, George Westinghouse, Alexander Graham Bell, Thomas Alva Edison, Charles Talbot Porter, Alfred Noble, Sir William Henry White, Robert Woolston Hunt, John Edson Sweet, James Douglas, Elihu Thomson and Henry Marion Howe. The award is made to Sir Robert Hadfield this year because of his invention of manganese steel.

The medal was established by the professional associates and friends of John Fritz, of Bethlehem, Pa., on August 21, 1902, his eightieth birthday, to perpetuate the memory of his achievements in industrial progress. There are no restrictions on account of nationality or sex. The trust funds supporting the medal are held and administered by a board of sixteen directors, consisting of four from each of the four national engineering societies represented on the mission to England.

Heating Association to Meet

The twelfth annual convention of the National District Heating Association is to be held at the Breakers Hotel, Cedar Point, Ohio, on Wednesday, Thursday and Friday, June 22, 23 and 24, 1921. Cedar Point lies just across Sandusky Bay from the City of Sandusky and is reached by the hourly boat to the hotel.

Some interesting addresses announced on the tentative program are: "Experience with Non-condensing Turbines in Industrial Heating Work"; "Symposium on Mechanical Stokers and Their Performances"; "Use of Pulverized Coal"; "The Coal Situation"; "Advantages of Central Station Heat from the Viewpoint of the Building Manager."

The midsummer meeting of the American Society of Heating and Ventilating Engineers will be held at Cleveland the week preceding the convention (June 14-17), so some may find it convenient to take in both meetings in one trip. The secretary of the National District Heating Association is D. L. Gaskill, Greenville, Ohio.

Recently announced figures on the production of electricity by public-utility plants in January indicate that the decline in the demand for electricity noticeable in December continued during January. The mean daily output for the month was 114,880,000 kw.-hr. This is about 8 per cent less than that for January, 1920, and is less than that for any month during 1920.

Society Affairs

The Providence Engineering Society is to meet May 3 to hear a talk on "Latest Stoker Practice," by S. C. Vandervoort, of the Westinghouse Co.

The Engineering Societies of Rochester will hold a joint dinner in the Powers Hotel at 6:30 pm., May 5. Calvert Townley, vice president of the Federated American Engineering Societies, will be the principal speaker.

The New York Engineers' Protective Society has arranged for a lecture to be given May 7 by Mr. Spangler, of the Carbondale Co., on "Refrigeration, or the Absorbtion Machine." The lecture will be given at the meeting rooms at the Bloomingdale Bldg., 60th St. and Third Ave., New York City.

The American Association of Engineers has arranged for an exhibit booth in connection with its seventh annual convention, which is to be held May 9-11 at the Lafayette Hotel, Buffalo, N. Y. An engineer, who will be in charge of this booth, will distribute catalogs, leaflets, data sheets, etc., to those attending the convention. Advertising is in charge of G. S. Hallenbeck, Buffalo Chapter A. A. E., 511 Brisbane Bldg., Buffalo, N. Y.

Miscellaneous News

Encouragement of Hydro-Electric Work through the use of state credit was proposed recently by George D. Leighton, Commissioner on Water Conservation of New Hampshire, in a report to the state legislature. He proposed that the credit of the state should be made available for loans to develop better storage facilities in the rivers of New Hampshire. Those who use the power would be required to supply enough income to pay interest on the loan and maintenance expenses and to accumulate a sinking fund. A committee of three to be appointed by the governor to discuss water-power development with representatives of other New England States has already been proposed in a bill that has been reported to the legislature.

Electric Drive is to be applied to two ferryboats of the Golden Gate Ferry Co., San Francisco, Cal. A contract has been awarded the Winton Engine Co., Cleveland, Ohio, for four 500-hp. Diesel engines which are to be direct-connected to Westinghouse generators. The propellers are to be driven by 250-volt direct-current motors. The installation resembles that of the yacht "Guinivere."

Business Items

The Standard Fuel Engineering Co. has moved to 667-677 Post Ave., South, Detroit, Mich.

The Superheater Co. has announced that after May 1, 1921, its general offices will be moved from 30 Church St. to 17 East 42nd St., New York City.

The International Pulverized Fuel Corp. has announced that after April 20th their general offices will be in the National City Building, 17 East 42nd Street, New York City.

Sheffler-Gross Co., Drexel Bldg., Philadelphia, has been appointed district representative of the Fisher Governor Co., and will carry a stock of Fisher products in Philadelphia.

The Botfield Specialties Manufacturing Co., Swanson and Clymer Sts., Philadelphia, Pa., is now trading under the name of "Botfield Refractories Co.," although its personnel remains the same.

The Batterman-Truitt Co. has outgrown its present manufacturing quarters and has recently negotiated a lease covering additional floors in the Gordon Building, at 730-38 West Monroe St., Chicago; this will triple its facilities and equipment for the manufacture of its line of motor-driven ventilating fans and blowers.

Trade Catalogs

The Sullivan Machinery Co., Peoples Gas Building, Chicago, has issued a new 6 x 9-in. 32-page bulletin, No. 77-B, describing its angle-compound power-driven air compressors.

W. S. Rockwell Co., 50 Church St., New York City, is sending out a new circular, bulletin No. 223, dealing with burners for oil and gas fuels as applied to industrial heating and heat-treating processes.

Henry Vogt Machine Co., Inc., Louisville, Ky., is distributing a new 8 x 10-in., 20-page bulletin describing its line of refinery equipment, including chilling machines, refrigerating machines, wax presses, boilers, fittings and grates.

The Fulton Iron Works Co., St. Louis, Mo., has put out a new 8½ x 11-in., 32 page catalog describing its line of Diesel engines. The Fulton Diesel is of the vertical "A" frame, four-stroke-cycle trunk-piston type. The catalog contains some interesting charts of costs and fuel consumption.

The M. H. Detrick Co., 155 East Superior St., Chicago, has recently brought out an unusually good 8½ x 11-in. catalog dealing with the Detrick arch. The book contains a great quantity of halftones and diagrams showing cross-sections and general views of the arch as installed with different types of boilers. The construction is very clearly shown, and the subject as a whole is covered completely.

FUEL PRICES

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run basis, f.o.b. mines):

Coal	Market Quoted	April 12 1921	April 19 1921
Pocahontas,	Columbus	$3.35	$3.25
Clearfield,	Boston	2.35	2.00@2.75
Somerset,	Boston	3.05	2.35@3.75
Pittsburgh,	Pittsburgh	2.25	2.00@2.50
Kanawha,	Columbus	2.25	2.00
Hocking,	Columbus	2.25	2.15
Pittsburgh No. 8	Cleveland	2.25	2.20@2.35
Franklin, Ill.,	Chicago	3.40	3.25@3.50
Central, Ill.,	Chicago	2.25	2.25@2.75
Ind. 4th vein,	Chicago	2.65	2.50@3.00
Standard,	St. Louis	1.90	1.90@2.00
West Ky.,	Louisville	2.40	2.00@2.50
Big Seam,	Birmingham	3.05	2.90@3.25
S. E. Ky.,	Louisville	2.65	2.75

DIESEL FUEL OIL

New York—On April 14, Port Arthur light oil, 23@25 deg. Baumé, 5½c. per gal. 30@35 deg., 6½c. per gal. f.o.b. Bayonne, N. J.

St. Louis—April 16, prices f.o.b. cars, tank lots: 24@26 deg. Baumé, 75c. per bbl.; 26@28 deg., 80c.; 28@30 deg., 85c.; 32@34 deg., 2¾c. per gal.

Baltimore—On April 12, f.o.b. Baltimore in tank-car lots: 24+ deg. Baumé, 6½c.; 26@28 deg., 6¾c.; 30@34 deg., 7¾c.; 14+ deg., $1.95 per bbl.; 16@20 deg., $1.85 per bbl.

Pittsburgh—On April 18, f.o.b. refinery; Pennsylvania, 36@40 deg., 4¾@5c. per gal.; Oklahoma, 26@30 deg., 75@80c.; gas oil, 32@34 deg. 2½c. per gal., 36@38 deg., 3¼c. 38@40 deg. 3½c.

Philadelphia—On April 12; 26@28 deg. Baumé, Oklahoma, 85c. per bbl.; 30@34 deg., Oklahoma (group 3) 3c. per gal.; 16@20 deg., Seaboard, 5c. per gal.

New Construction

PROPOSED WORK

Mass., Reading—The Commonwealth of Massachusetts, 1 Ashburton Pl., Boston, is having plans prepared for a 1 story, 30 x 40 ft. sewage pumping station to include pumps, etc. About $35,000.

N. Y., Buffalo—The city will receive bids until April 28 for electrically operated control for 10-48 in. valves and 5-36 in. valves (high and low pressure), 10,500 ft. No. 4 Park cable and 1,600 ft. No. 10 Park cable, etc. for transmission lines. G. H. Andrews, Municipal Bldg., Water Comr.

N. Y., Buffalo—G. B. Post & Son, Archts. and Engrs. 101 Park Ave. New York City, will receive bids until April 27 for a 17 story hotel on Delaware Ave. and Niagara Sq., for the Hotel Statler Co., Washington Sq. About $5,500,000.

N. Y., Buffalo—The State Hospital Comn., Capitol, Albany, received bids for alterations and additions to the central heating plant at the State Hospital here from J. W. Danforth Co., Ellicott Sq., $54,399; Moran & Gibbs, Niagara Life Bldg., $55,750; Power Efficiency Corp., 603 White Bldg., $55,768.

N. Y., Medina—The Bd. Educ. plans to build a 2 story school including a steam heating system. About $400,000. W. B. Ittner, Bd. Educ. Bldg., St. Louis, Mo., Archt.

N. Y., New York — (Bronx Boro) The Pres. of the Bd. Educ., 500 Park Ave., New York City, will receive bids until April 27 for installing heating and ventilating apparatus, etc. in P. S. 43, on 136th St. and Brown Pl., here. C. B. J. Snyder, Municipal Bldg., Engr.

N. Y., New York—(Manhattan Boro) The Bd. Educ. 500 Park Ave., plans to build a 5 story school between 188th and 189th Sts. and Amsterdam Ave. About $500,000. C. B. J. Snyder, Municipal Bldg., Archt. and Engr.

N. Y., New York—(Manhattan Boro) The Bd. Educ. 500 Park Ave., is having plans prepared for a high school including a steam heating system to be known as the George Washington High School on Amsterdam and Audubon Aves. About $850,000. C. B. J. Snyder, Municipal Bldg., Archt. and Engr.

N. Y., New York — (Manhattan Boro) Columbia University Morningside Drive, plans to build a faculty and chemistry building including a steam heating system on Morningside Drive and 117th St. About $1,000,000. McKim, Mead & White, 101 Park Ave., Archts. and Engrs.

N. Y., New York — (Manhattan Boro) The Forty-Nine West 45th St. Corp., c/o J. Sloane and V. C. Farrar, Archts. and Engrs., 4 East 39th St., is having plans prepared for a 12 story, 56 x 100 ft. office building including a steam heating system at 49-53 West 45th St. About $350,000.

N. J., Atlantic City—Hotel Shelbourne, Michigan and Beach Aves., will soon award the contract for an addition to its hotel. About $500,000. Warren & Wetmore, 10 East 47th St., New York City, Archts.

N. J., Atlantic City — W. G. Souders (Banker), 208 La Salle St., Chicago, Ill., is having plans prepared for a 5 story, 100 x 160 ft. apartment hotel on Albany Ave., here. About $3,000,000. R. S. DeColyer, 7 South Dearborn St., Chicago, Ill., Archt.

N. J., Cape May — The Bd. Educ. will soon receive bids for removing old heating plant and installing a new high pressure steam boiler for heating a school. H. L. Roberts, 228 North 16th St., Philadelphia, Pa., Engr.

N. J., Oaklyn—The Suburban Constr. & Supply Co., 215 White Horse Pike, will receive bids until Sept. 1 for the installation of an electric coal and stone conveyor.

N. J., Ocean City—The Embassy Hotel c/o H. Y. Lake, plans to build a 12 story, 259 x 500 ft. hotel including a steam heating system, here. About $1,250,000. Clinton & Russell, 32 Nassau St., New York City, Archts.

N. J., Trenton—The State House Comn. plans to build an office building for the State Capital on West Hanover St. About $450,000. Architect not yet selected.

N. J., Wildwood—Hotel Sheldon plans to install a new steam heating boiler.

N. J., Wildwood—The Wildwood Lumber Co. will receive bids about Sept. 1 for the installation of an electric crane conveyor.

Pa., Philadelphia — J. E. Burt, c/o F. Webber, Archt., Morris Bldg., is having plans prepared for a 15 story, 60 x 178 ft. office building at 1015-17-19 Chestnut St. About $2,000,000.

Pa., Philadelphia — The Dept. of Pub. Wks. will soon award the contract for furnishing available voltage arc welding and generator set, etc. J. T. Cortelyou, City Hall, Dir.

Pa., Philadelphia—Gimbel Bros., 9th and Market Sts., plans to build a 12 story department store on 9th and Chestnut Sts. About $2,000,000. Graham, Anderson, Probst & White, 80 East Jackson Blvd., Chicago, Ill., Archts.

Pa., Reading—The School Bd. is having plans prepared for a 3 story junior high school on 6th and Court Sts. About $600,000. Drehn, Churchman, Paul & Ford, 1424 Walnut St., Philadelphia, Archts.

Md., Baltimore—The Crane Ice Cream & Baking Co., Spruce St., Philadelphia, Pa., plans to build an ice cream plant including a refrigeration system on Greenmount Ave. near Preston St., here. K. W. Schantz, 768 Potomac Ave., Buffalo, N. Y., Engr.

Ala., Birmingham—The Louis Pizitz Dry Goods Co., 118 19th St., plans to build a 6 story, 140 x 200 ft. department store on 2d Ave. and 19th St. About $1,500,000. H. B. Wheelock, Steiner Bldg., Archt.

Tenn., Pulaski—The Water Com. will receive bids until April 27 for installing waterworks equipment for city plant consisting of 1,000,000 gal. gravity filtration plant, pumping engines, etc. W. J. Yancey, Chn. Klyce & Kackley, 4th and 1st Natl. Bank Bldg., Engrs.

Ky., Harrodsburg — The city engaged Greeley, Pearse & Hausen, Engrs., 39 West Adam St., Chicago, Ill., to prepare plans for the installation of a water supply system and repairs to present electric light plant here. About $100,000.

O., Cincinnati—The Towers Hotel Co., 833 Union Trust Bldg., is having plans prepared for a 6 and 7 story, 150 x 250 ft. apartment hotel on Paddock Rd. About $2,700,000. Dittoe, Fahnestock & Ferber, Commercial Tribune Bldg., Archts. Euphrat & Hanley, 305 Walnut St., Engrs.

O., Cleveland—The city received bids for the installation of a refrigerating system for the new hospital buildings from the Phoenix Ice Machine Co., West 26th St. and Clinton Ave., $37,736.

O., Dayton—The B. F. Keith Theater Interests, 1564 Bway, New York City, is having preliminary plans prepared for a 4 story, 100 x 125 ft. theater and office building including a steam heating system on 4th and Ludlow Sts. About $1,250,000. Rapp & Rapp, 190 North State St., Chicago, Ill., Archts.

O., Lakewood — (Cleveland P. O.) The Bd. Educ., c/o G. W. Grill, Warren Rd., received bids for a 2 story, 110 x 168 ft. school on Athens Ave., from the Schirmer O'Hara Co., 2031 Euclid Ave., Cleveland, $126,860; C. R. Cummins Co., Swetland Bldg., Cleveland, $129,000.

O., Xenia — The Bd. Educ. will receive bids about May 13 for a 2 story, 128 x 250 ft high school on Church St. About $385,000. J. Beachem, Clk. Pretzinger & Musselman, Ribbold Bldg., Dayton, Archts.

Ind., South Bend — The Palace Theater Co. is having plans prepared for a 2 story, 125 x 180 ft. theater and store building including a steam heating system on Colfax Ave. About $750,000. J. S. Aroner & Co., 25 East Jackson St., Chicago, Ill., Archt. Noted March 9.

Mich., Detroit—The City and County, 312 County Bldg., is having plans prepared for operating houses, enclosing walls and the installation of operating equipment for the West Jefferson Ave. Bridge. About $35,000. H. A. Shuptrine, County Bldg., Engr.

Mich., Detroit — Esselstyn, Murphy & Hanford, Archts. and Engrs., Marquette Bldg., plans to build a 2 story theater including a steam heating and washed air ventilating system on Woodward Ave. About $350,000. Owner's name withheld.

Mich., Detroit — Albert Kahn, Archt., Marquette Bldg., will receive bids about April 28 for a 4 story, 135 x 200 ft. apartment house and stores including a steam heating system on Hague and Woodward Aves., for the Wineman Realty Co., 150 Michigan Ave. About $300,000.

Mich., Lansing — The Prudden Building Co. plans to build a 10 story, 48 x 122 ft. mercantile and office building on Michigan and Washington Aves. S. D. Butterworth, Archt.

Mich., Monroe—The Monroe Water Co. is having plans prepared for the installation of a 5,000,000 gal. pump, etc. J. N. Chester, Union Bank Bldg., Pittsburgh, Pa., Engr.

Mich., Springwells — St. Alphonsus Parish, c/o Donaldson & Meir, Archts., 1314 Penobscot Bldg., Detroit, had plans prepared for a 2 story school including a steam heating system on Warren Ave. and Shaefer Rd. About $350,000.

Ill., Chicago—The Chicago & Northwestern R.R., 226 West Jackson St., will receive bids until April 27 for 1 boiler complete for class R-1 engine, and 1 boiler complete for class R. engine.

Ill., Chicago—Lubliner & Trinz, 25 East Jackson St., plans to build a 1 story, 125 x 250 ft. theater including a steam heating system on Milwaukee and Sawyer Aves. About $800,000. W. W. Ahlachlager, 65 East Huron St., Archt.

Ill., Chicago — W. Pickell, 4451 Beacon St., plans to build a 3 story, 100 x 200 ft. apartment hotel including a steam heating system at 4124 Sheridan Rd. About $350,000. P. F. Olson, 127 North Dearborn St., Archt.

Ill., Chicago — Plotke & Grosby, 2519 North Clark St., are having plans prepared for a 3 story, 125 x 160 ft. apartment house including a steam heating system on Mongolia and Bryn Mawr Aves. About $300,000. A. V. Teisen, 3133 Logan Bl., Archt.

Ill., Chicago — The Womans' Hospital, c/o Dr. L. C. Merrill, 25 East Jackson Blvd., is having plans prepared for an 11 story, 100 x 125 ft. hospital including a steam heating system at 460 East 32d St. About $1,500,000. E. Grosman, 631 North Michigan Ave., Archt. and Engr.

Ill., Cicero — Filas & Vittner, Archts., 5322 West 25th St., plan to build a 5 story, 125 x 150 ft. hotel including a steam heating system on 25th St. and 53d Ave. About $600,000. Owner's name withheld.

Wis., Madison—The School Bd. will receive bids about May 1 for a 3 story, 70 x 263 ft. high school on East Washington St. About $300,000. C. H. Meeks, Supt. F. M. Riley, Archt.

Wis., Milwaukee — The Comr. of Pub. Wks. will soon award the contract for the test borings for the Riverside Pumping station. About $1,500,000. G. Staal, City Hall, Engr. Noted April 12.

Kan., Minneapolis—The city voted $60,000 bonds to construct a power plant. A. D. Todd, Clk.

Kan., Morganville — The city plans to build an electric light plant here. A $22,000 bond issue was voted upon for the project. W. B. Rollins Eng. Co., Rwy. Exch. Bldg., Kansas City Mo., Engr.

Kan., Rosedale — The State Medical School, Topeka, is having plans prepared for a 3 story, 46 x 164 ft. hospital including a steam heating system, here. About $400,000. R. L. Canible, State House, Topeka, Archt.

N. D., Zap—The village plans an election April 25 to vote on $45,000 bonds to construct an electric light plant.

Wyo., Cheyenne—The School Bd. is having plans prepared for a 3 story, 100 x 250 ft. high school including a steam heating system on 20th St. between Capitol and Central Aves. About $365,000. W. Duboice, Archt.

Mo., Columbia—The University of Missouri plans to build a 1 story heating plant. About $150,000. J. J. Babb, Secy. James P. Jamieson, Security Bldg., St. Louis, Archt.

Tex., Ballinger—The city plans to build an electric light plant. An election is planned to vote on $75,000 bond issue for the project. S. S. Guin, Mayor.

Tex., Dallas—The Dallas Athletic Club is having plans prepared for a 12 or 13 story club on Elm and St. Paul Sts. About $1,750,000. Lang & Mitchell Amer. Exch. Natl. Bank Bldg., Archt. Noted Dec. 14.

Okla., Ardmore—The State Natl. Bank plans to build a 10 story, 47 x 120 ft. bank and office building on Main and North Washington Sts. About $250,000. Architect not yet selected.

Okla., Duncan—The Bd. of Comrs. plan an election to vote on $600,000 bonds for a water supply system, 2,000,000 gal. reservoir, 800 k.w. electric light plant, electric distributing system, etc. R. Frensley, Clk. Benham & Mullergren, Firestone Bldg., Kansas City, Mo., Consult. Engrs.

Okla., Oklahoma City — The Doctors & Dentists Trust Co., c/o Dr. J. S. Pine, plan to build a 10 story professional office building. About $600,000.

Okla., Oklahoma City — The Kerr Dry Goods Co., 226-32 North Main St., is having plans prepared for an 8 story, 80 x 140 ft. department building including a steam heating system on Main St. between Hudson and Harvey Sts. About $500,000. W. T. Schmidt, 1634 West 10th St., Archt.

Okla., Okmulgee — The Okmulgee Brick Co. plans to build a paving brick plant including a Dressler type railroad tunnel kiln and cars. All electrically operated machinery with 545 connected hp. will be installed in same. About $200,000. R. E. Buckles, Engr.

Okla., Weletka—The city had plans prepared for extensions to the waerworks and additions to the light plant. About $180,000. V. V. Long & Co., 1300 Colcord Bldg., Oklahoma City, Engr. Noted March 15.

Cal., Long Beach — The American Ave. Development Co., c/o H. H. Lochridge Archt., 700 Markwell Bldg., is having plans prepared for a 12 story bank and office building on 3d St. and American Ave. About $1,250,000.

Ont., Hamilton — The Hospital Bd. had plans prepared for a 4 story, 50 x 180 ft. nurses home including a steam heating system on Barton St., East. About $350,000. Secord & Murton, Home Bank Bldg., Archts.

Ont., London—The Dept. of Pub. Wks. will receive bids until April 28 for alterations and additions to the steam heating apparatus at the Westminster Psychopathic hospital here.

Ont., Port Hope—The Port Hope Hospital Trust Co., will soon award the contract for a 2 story, 40 x 77 ft. laundry building including a steam heating system, here. About $50,000. Ellis & Ellis, Manning Chambers, Toronto, Archts.

Ont., Toronto—The Hydro Electric Comn. of Ontario, University Ave., plans to build a substation and a station for radial electric railway on York St. About $200,000.

Ont., Walkerville—The City Council plans to build a high school on Willistead St. and is in the market for equipment. About $400,000.

Ont., Wingham—The city engaged W. Chipman, Engr., Mail Bldg., Toronto, to prepare plans and submit estimates on proposed waterworks extensions, to include new electrical pumps and distribution systems, here. About $50,000.

CONTRACTS AWARDED

N. C., Charlotte — The Proximity Mfg. Co. has awarded the contract for a pumping station, filter plant, etc., to Tucker & Laxton, Realty Bldg. About $200,000.

Ia., Quimby—The city has awarded the contract for a pump house including machinery, to the Pittsburgh Des Moines Steel Co., 9th and Tuttle Sts., Des Moines, at $14,836.

Minn., Breckenridge — The city has awarded the contract for an electric light and power distributing system to the Electric Constr. Co., 175 East 6th St., St. Paul, at about $28,000.

Minn., South St. Paul—(St. Paul P. O.) The city has awarded the contract for one deep well centrifugal, electric motor driven pump of 1,000 gal. capacity against min.-max. head of 300-325 ft. and one booster centrifugal pump on reservoir floor with 250 gal. per min. capacity against 85-120 min.-max. head, to the John W. Hildred Co., 1019 Commerce Bldg., St. Paul at $14,306. Contract includes pump house, etc. Noted April 19.

Minn., Wilmar—The city has awarded the contract for one steam horizontal tubular type boiler, 18 ft. long and 72 in. in diameter, weighing pressure 150 lb. per sq. in. and equipment, to Benjamin Benson at $6,355.

S. D., Elk Point—The city has awarded the contract for a sewage system including a pumping plant, equipment, etc., to O. N. Gjellafald, Forest City, Ia., at $52,100. Noted Jan. 4.

Okla., Mountain View — The city has awarded the contract for a power plant to include two 80 hp. boilers, 50 and 125 hp. engines, to C. H. Everett, Hutchinson, Kan. About $30,000. Noted March 15.

Ont., Peterborough — The City Council has awarded the contract for installing pumps in the proposed filtration plant here, to Escher Wyss & Co., 285 Beaver Hall Hill, Montreal, Que.